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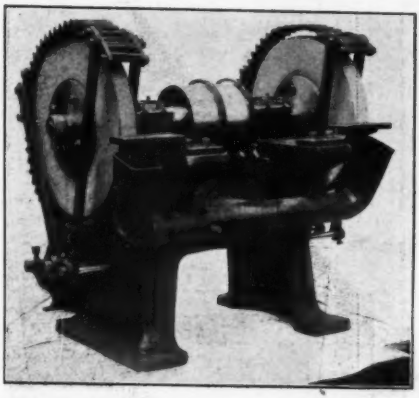

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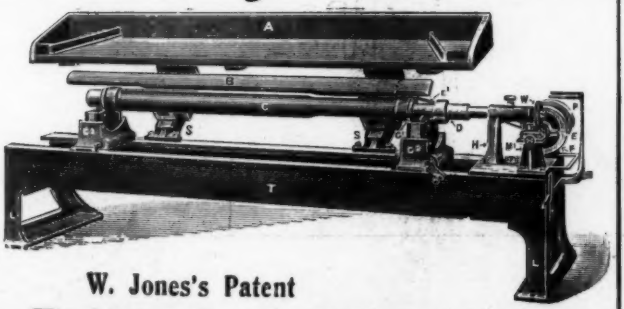

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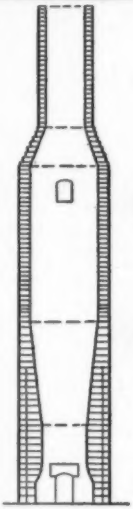

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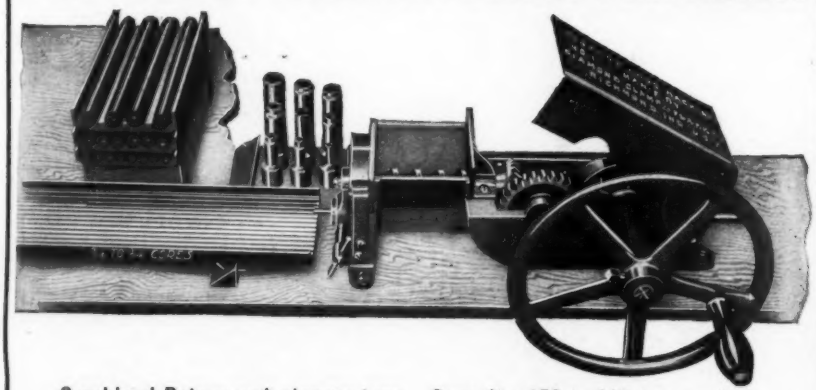

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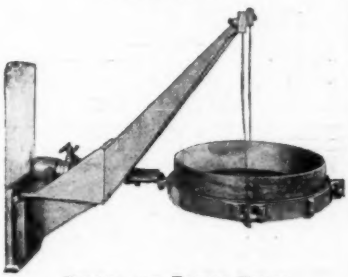

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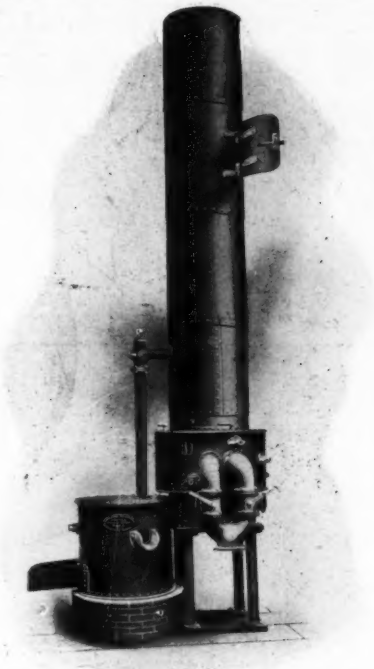

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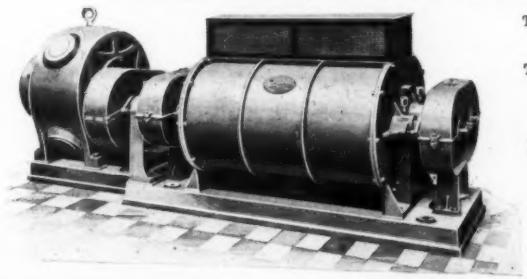

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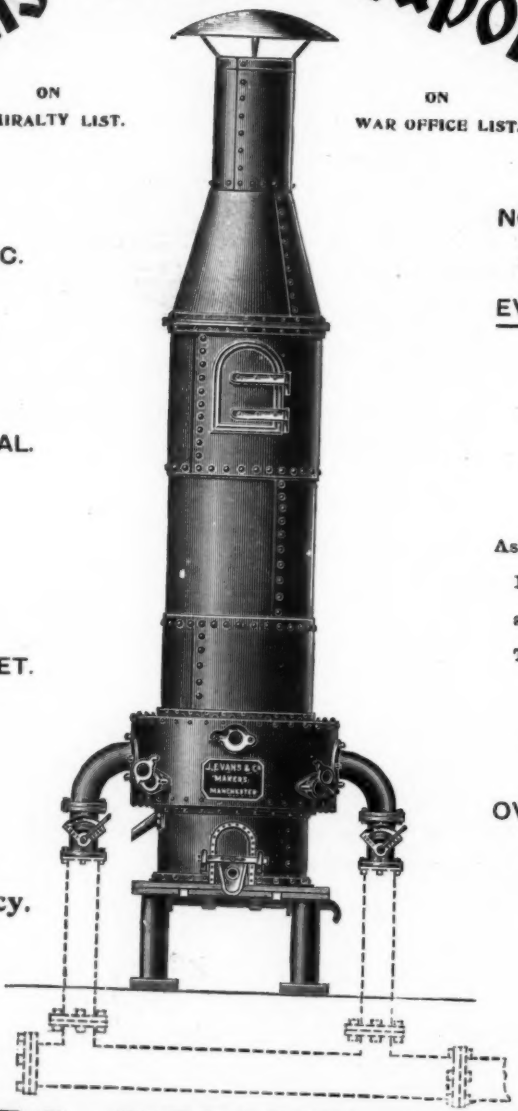

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Vol. 10. JANUARY, 1908. No. 73.

—PUBLISHED—

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NOTES AND COMMENTS.

Foundry Reciprocity.

MANY and various have been the reasons given for the rapidity which has marked the progress of trade in America. In no trade has this progress been so marked as in that which is associated with foundry work. The position which America holds in regard to its natural resources is unique. It has also benefited to a large extent by the influx of immigrants, who have poured in from all the trade centres of the world. In this way it has had the combined efforts and brain power of all nations centralised on its trade.

There is certainly a large element of truth in these statements, and in many other factors which might be quoted. We consider, however, that to a greater degree, the success which has attended America may be directly attributed to the spirit of reciprocity which largely predominates in that country. Now we have the greatest admiration and praise for any individual, class, or community, that is willing, at any time, to show others what they have been doing to further the interests of progress in any shape whatsoever.

If this feeling were universal, it would clear the path of many difficulties, and be to the mutual benefit of all; but, unfortunately, such is not the case, as will be seen from the following communication which has passed from the Secretary of the American Foundrymen's Association to the members of that body.

"For more than thirty years," he says, "we have let a steady stream of German engineers visit our industrial establishments, coming with notebook, footrule, and sometimes a brazen assurance. They have carried away tons of blue prints generously given them, and when our American manufacturers go abroad occasionally a board of directors' meeting has to be called before admission is officially—refused.

The Secretary goes on further to state, "That unless a promise is given to reciprocate, credentials from this office to American foundries are refused."

An Old Grievance.

This is an old grievance, and the results have worked out in exactly the same manner, as we have witnessed time and again. We do not require to travel to Germany to find examples of this form of selfishness, nor is it wholly confined to the foundry trade. It is a disease far too common, and is found in many forms and in all grades of society. We have observed during our experience that those who are most persistent in their demands, even to the point of impertinence, are those who are most reticent when information of any kind is desired from them.

The latter part of the communication to which reference has been made reminds us of the workman who had seen the evils of this practice, and when asked by any one for information regarding some difficulty, would first get an assurance from the questioner that in the event of seeing anyone in the same difficulty he would impart the information he was about to receive.

There may be some excuse for those who have gained some desired object from original research, in order that they may in some measure be recompensed for the trouble and expense of such research, but we consider there is positively no excuse for any one who takes advantage of, and is profited by, information which has been imparted to him. He is in duty bound to reciprocate this kindness when the opportunity of doing so arises.

An Example.

What we should like to see amongst our trades, and particularly the foundry trade, is that feeling which predominates in municipal affairs, where one community is only too pleased to show to another anything which may be to the advantage of the other.

This is, perhaps, too much to ask in this age of competition, but we are confident if this spirit of reciprocity were universally established it would be to the mutual benefit of all.

——o——

FOUNDRY BLOWER PRACTICE.*

By Walter B. Snow.

Modern foundry practice in the melting of metals is fundamentally dependent upon the blower. As the successor of the blow-pipe and the bellows, it has made possible the massing of fuel in large quantities, with greater imposed resistance, the production of higher temperatures, and the better utilisation of the heat in the furnace.

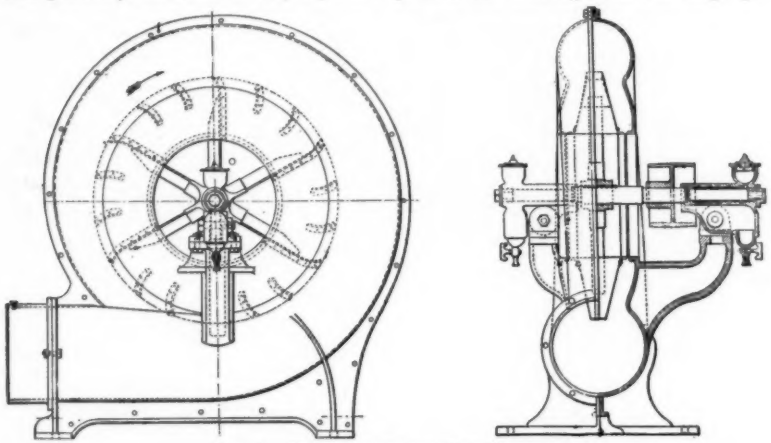

Fig. 1.—Elevations of Fan Blower.

The primary function of a blower is to move air against resistance. Its performance is dependent upon the relation expressed by the formula:—

$$V = \sqrt{2gh} \qquad [1]$$

in which V = velocity in feet per second; h = head in feet; g = acceleration due to gravity = 32.16; or

$$V = \sqrt{2g\frac{p}{d}} \qquad [2]$$

when h is expressed in terms of p = pressure and d = density.

*Presented at the New York meeting of the American Society of Mechanical Engineers.

When applied under the conditions of p = pressure in ounces per square inch, d = density or weight per cubic foot of dry air at 50 degrees Fahr. and under atmospheric pressure of 14.69 pounds or 235 ounces = 0.077884 pounds, formula [2] becomes

$$V = \sqrt{64.32 \times \frac{p \times 144}{16 \times 0.077884 \times \frac{235 + p}{235}}} \quad [3]$$

which reduces to

$$V = \sqrt{\frac{1746659 \times p}{235 + p}} \quad [4]$$

Allowance is evidently made therein for compression of air but not for change of temperature during discharge. The velocities in the basis Table 1 were calculated by this formula. The tabulated volume is in each case the product of velocity and effective area.

TABLE 1.—*Relations of Pressure, Velocity, Volume, and Horse-power.*

Pressure per sq.in. Ozs.	Velocity of dry air at 50 degrees Fahr. escaping into outer system through any shaped orifice.		Volume discharged per in 1 minute through an orifice having effective area of 1 sq. in. Cubic feet.	Horse-power required to move given volume under given conditions
	Ft. per sec.	Ft. per sec.		
1 ..	86.03	5,161.7	35.85	0.00978
2 ...	121.41	7,284.4	50.59	0.02759
3 ..	148.38	8,902.8	61.83	0.05058
4 ..	170.98	10,258.6	7 .24	0.07771
5 ...	190.76	11,445.5	79.48	0.1084
6 ...	208.53	12,511.9	86.89	0.1422
7 ..	224.77	13,486.4	93.66	0.1788
8	239.80	14,387.9	99.92	0 2180
9	253.83	15,229.6	105.76	0 2596
10	267.00	16,020 4	111 25	0.3034
11	279.70	16,768.1	116'45	0.3493
12	291.30	17,478.2	121'38	0.3972
13	302.59	18,155.2	126'06	0.4470
14	313.38	18,802.7	130'57	0.4986
15 ..	323.73	19,423.6	134-89	0.5518
16	333.68	20,020.7	139.03	0.6067
17 ..	343.26	20,585.8	143.03	0.6631
18	352.52	21,151.0	146.88	0.7211
19	361.46	21,687.8	150.61	0.7804
20 ..	370.13	22,207.5	154.22	0.8412

The theoretical horse-power is the product of pressure, velocity, and effective area. For refined work, or under conditions of wide variation from the basis of the table, corrections should be made for differences in humidity and temperature.

In the ordinary processes of the foundry, where iron or the less refractory metals are to be reduced, the resistance of the crucible, air, or cupola furnace will roughly range from somewhat above 1 oz. to a possible but usually unnecessary pressure in excess of 20 ozs. per square inch.

Up to about 8 ozs. the fan blower cannot be excelled for convenience and efficiency. From 8 to 16 ozs. the field is fairly divided between the fan and the rotary types, the advantage gradually shifting from the former to the latter as the pressure increases. Above 16 ozs. the superiority of the rotary type is manifest, until it in turn encroaches upon the efficient field of the blowing engine at about 5 lbs.; a pressure far in excess of the practical requirements of the foundry. The air compressor, as an aid to combustion, is economically useful only in connection with the burning of liquid fuel.

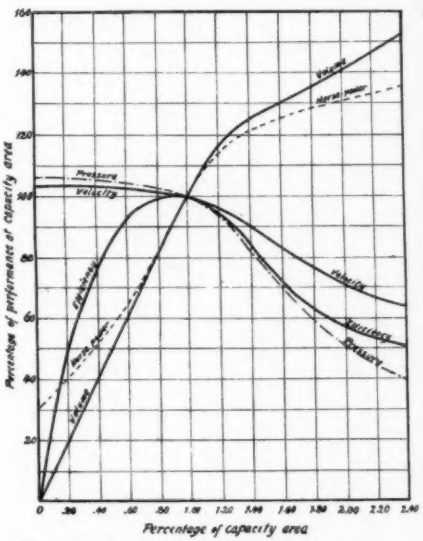

FIG. 2.—RELATIVE PERFORMANCE OF A FAN AT CONSTANT SPEED WITH VARIABLE OUTLET APEA.

The fundamental differences between the fan and the rotary type of blower lie in the manner of creating pressure and in the effect of resistance. In the fan type, velocity is given to the air in its passage from the inlet to the circumference of the revolving wheel. This is transformable into pressure with corresponding density within the enclosing case and connections; the pressure being dependent upon the number of revolutions. In the case of a fan blower at constant speed, the volume and power decrease as the resistance increases. When the outlet is closed, the wheel continues to revolve at the same speed, but

without effective delivery, and with minimum power expenditure.

In the rotary, or so-called "positive" type, air in regularly succeeding volumes is imprisoned by one or more enclosed revolving impellers, and forced forward against the imposed resistance. It is thereby compressed to a density, and given a pressure proportionate to that resistance. This pressure is fundamentally independent of the number of revolutions. The delivery remains practically constant for a given speed as long as discharge is permitted, while the power expenditure increases with the resistance. When the outlet is closed, the power required is at the maximum, and the displacement, though ineffective, is just equal to the slip; up to the limit of power to drive and of strength to endure.

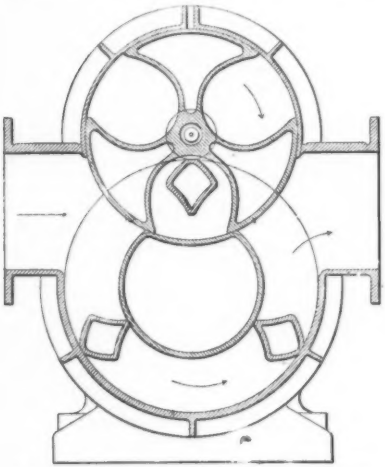

FIG. 3.—ROTARY BLOWER, SINGLE IMPELLER, TRIPLE BLADED TYPE.

The construction and proportions of a prevalent type of cupola fan blower are illustrated in Fig. 1. The casing and wheel are provided with two inlets, which, in ordinary construction, are about one-half the diameter of the wheel. The width of such a wheel at its periphery ranges from 5 to 8 per cent. of the diameter, the width between side plates at the inlet being approximately one-sixth of the diameter. From 6 to 8 major blades extend from inlet to circumference; between these are one, two or three times as many minor blades of about one-half the radial length. All blades are slightly curved backwards at the circumference of the wheel. The cast-iron casing is of involute form, its greatest diameter being approximately one and three-quarter times the diameter of the enclosed wheel.

In the volume type, designed for much lower pressures, such as are required in air furnace operation, the peripheral width of the wheel ranges from 20 to 40 per cent. of its diameter. The casing is often of steel plate.

The manufacturers' rating of the type of blower shown in Fig. 1 is based upon the greatest effective area over which it will maintain the maximum velocity of discharge. As originally established by

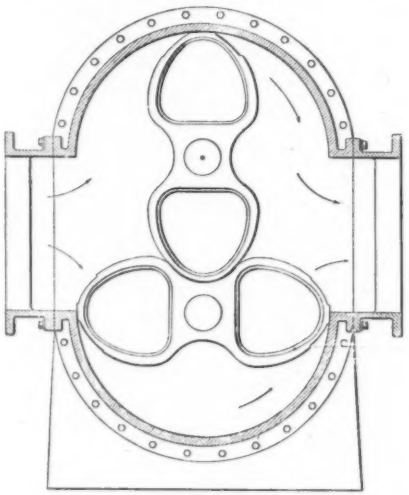

FIG. 4.—ROTARY BLOWER, DOUBLE IMPELLER TYPE.

Sturtevant, this "capacity area" or "square inches of blast" is represented by the empirical formula

$$\text{Capacity area} = \frac{DW}{3} \qquad [5]$$

in which D = diameter of wheel in inches; W = width of wheel at circumference in inches. This formula was derived from the pressure type of fan blower. The value of the divisor must necessarily vary with the proportions of the wheel, the number of inlets, the number and curvature of the blades, and the form of the enclosing case. But as a merely arbitrary basis, the formula has been generally accepted for the ready

comparison of wheels of substantially the same type.

Manifestly the maximum velocity of discharge will create the maximum total pressure. As a factor in the manufacturer's rating this attainable velocity has been accepted as being equal to the circumferential speed of the wheel. This assumption is by no means universally correct.

Recent developments in fan construction with very large inlets, numerous shallow blades, and unusual width, show discharge velocities far in excess of the circumferential speed, approximating a theoretical maximum of twice that speed. But successful application of such fans has not yet been made under the resistance obtaining in cupola practice.

tuting a larger and more costly fan for one that must be run at unnecessary speed to deliver the required volume.

The speed of a fan is usually fixed, and variations occur only in the effective area of discharge. In cupola practice such variation is extensive, and changes often succeed each other with frequency. Hence, it is difficult to proportion the fan to secure the most economical average performance. It must have capacity to deliver the required volume under the greatest resistance toward the end of the heat, but the power provided must be sufficient to drive it during the early part of the heat when there is less resistance, greater delivery, and consequently more work to be done.

For the ordinary type of fan it has

TABLE 2.—*Performance of Cupola Fan Blowers at Capacity Area per inch of Peripheral Width.*

Diameter of wheel. Inches. Capacity area sq. ins.	Item.	Total pressure in ounces per square inch.										
		6	7	8	9	10	11	12	13	14	15	16
18 in. 6 sq. in.	r.p.m. ...	2660.0	2860.0	3050.0	3230.0	3400.0	3560.0	3710.0	3850.0	3990.0	4120.0	4250.0
	cubic feet ...	520 0	560.0	600.0	640.0	670.0	700 0	730.0	760.0	780.0	870.0	830.0
	horse-power	1.7	2 1	2.6	3 1	3.6	4.2	4.8	5.4	6.0	6.6	7.3
24 in. 8 sq. in.	r.p.m. ...	2000.0	2150.0	2290.0	2420.0	2550.0	2670 0	2780.0	2890.0	2990.0	3090.0	2190.0
	cubic feet ...	700 0	750 0	800.0	850.0	890.0	930.0	970.0	1010.0	1040.0	1080.0	1110.0
	horse-power	2 3	2.9	3.5	4.2	4.9	5 6	6.4	7 1	8.0	8.8	9.7
30 in. 10 sq. in.	r.p.m. ...	1590.0	1720.0	1830.0	1940.0	2040.0	2140.0	2230.0	2310.0	2390 0	2470.0	2550.0
	cubic feet ...	870.0	940.0	1000.0	1060.0	1110.0	1160.0	1210.0	1260.0	1310.0	1350.0	1390.0
	horse-power	2 8	3.6	4.4	5.2	6.1	7.0	7,9	8.9	10.0	11.0	12.1
36 in. 12 sq. in.	r.p.m. ...	1330.0	1430.0	1530.0	1620.0	1700.0	1780.0	1850.0	1930.0	2000.0	2060.0	2120.0
	cubic feet ...	1040.0	1120.0	1200.0	1270.0	1340.0	1400.0	1460.0	1510.0	1570.0	1620.0	1670 0
	horse-power	3.4	4.3	5.2	6.2	7.3	8 4	9.5	10.7	11.9	13.2	14.5
42 in. 14 sq. in.	r.p.m. ..	1140.0	1230.0	1310.0	1380.0	1460.0	1530.0	1590.0	1650.0	1710.0	1770.0	1820.0
	cubic feet ...	1220.0	1310.0	1400.0	1480.0	1560 0	1630 0	1700.0	1770.0	1830.0	1890.0	1950 0
	horse-power	3.9	5.0	6.1	7.3	8.5	9.8	11.1	12.5	13.9	15.4	17.0
48 in. 16 sq. in.	r.p.m. ...	1000 0	1070.0	1150.0	1210.0	1270.0	1330.0	1390.0	1450.0	1500 0	1550.0	1590.0
	cubic feet ...	1390.0	1500.0	1600.0	1690.0	1780.0	1860.0	1940.0	2020.0	2090.0	2160.0	2230.2
	horse-power	4.5	5.7	7.0	8.3	9.7	11.2	12.7	14.3	15.9	17.7	21.0

It is evident that, disregarding the effect of changes in density and temperature, the following relations should hold for a given fan with constant capacity area: (*a*) the volume varies directly as the revolutions. (*b*) the pressure varies directly as the square of the revolutions, (*c*) the power varies directly as the cube of the revolutions.

These relations clearly point to the economic desirability of closely proportioning the fan to the work it is to perform. An increase of only 25 per cent. in the speed, which may be necessitated by deficiency in the volumetric capacity of a given fan, nearly doubles the power required, and creates a pressure more than 50 per cent. in excess of that at normal speed. It is seldom that the sum of fixed charges and operating expense cannot be materially reduced by substi-

been generally accepted that within the capacity area, (*a*) the velocity and pressure are maximum and constant; (*b*) the volume and horse-power are proportional to the area. These relations are only approximate, as is evident from Fig. 2. The curves are characteristic of an individual instance in which the fan ran at constant speed while discharging through various outlet areas. All values are relative to the performance at capacity area. Changes in the proportion or the speed of the fan would materially affect these relations, causing them to approach or recede from the conditions expressed in the preceding paragraph, and shifting the point of maximum efficiency.

These curves serve to show that (*a*) maximum efficiency in power and pressure are secured at or near the capacity area. (*b*) The power per unit

of volume and the pressure decrease as the discharge area and volume increase. (c) With closed outlet the power is approximately one-third of that at capacity area.

From the preceding it must be manifest that no simple exact basis of calculation can be established for varying fan proportions and conditions. For all practical purposes, however, the manufacturer's basis, although only approximately correct, is sufficiently accurate, particularly in cupola practice, where operation at or near the capacity area is essential. Upon this basis Table 2 has been calculated to show the performance at capacity area per inch of peripheral

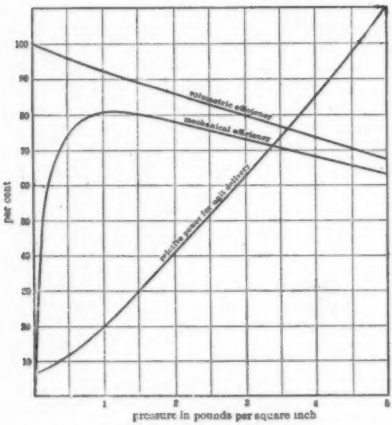

FIG. 5.—RELATIVE PERFORMANCE OF A SINGLE IMPELLER ROTARY BLOWER, AT CONSTANT SPEED, WITH VARIABLE RESISTANCE.

width of typical diameters of cupola fan blowers. Basic values are taken from Table 1, the air being dry, and of 50 degrees Fahr. temperature; the velocity of discharge is taken as equal to the circumferential speed of the wheel, and the power as double the theoretical. While 50 per cent. efficiency is below that which may be attained in good cupola installations, it is always desirable to provide ample surplus above the power required at capacity area. Even a change of 50 degrees from the ordinary inlet temperature makes a difference of about 10 per cent. in the power.

Characteristic types of single and double impeller rotary blowers are presented in Figs. 3 and 4. Numerous other designs are, or have been, in use. In the type shown in the skeleton cross-section in Fig. 3, the single impeller is made up of three diamond-shaped blades extending from a central web. On either side of the web a stationary core fills the space within the inner circumference of the blades, forming in connection with the enclosing case an annular space within which they revolve. The rotor which coincidentally revolves in the smaller portion of the casing, successively provides pockets to receive and pass the revolving impeller blades to the suction side of the blower, without allowing the escape of compressed air. The rotor is in effect

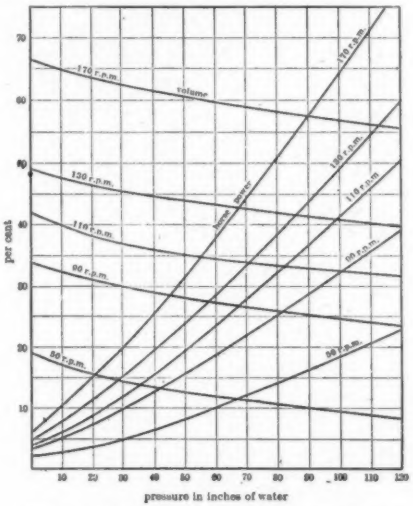

FIG. 6.—RELATIVE PERFORMANCE OF A DOUBLE IMPELLER ROTARY BLOWER, AT VARIOUS SPEEDS AND PRESSURES.

an idler which calls for no power expenditure other than that required to overcome friction.

In the type shown in Fig. 4 both impellers are symmetrical and counterparts of each other. The surfaces are so formed, and the impellers are so located on their respective shafts, as to permit of rotation with uniform clearance, and without metallic contact. Release of air on the discharge side of each impeller is practically coincident with the cut-off of admission on the inlet side.

In both types the air passing through the inlet is imprisoned and carried forward to the outlet side. Here it meets and mingles with an air of greater density, already compressed by previous action of the impellers. Equalisation of pressure instantly results. As a conse-

quence, there is more or less fluctuation coincident with the revolutions of the blower. The degree of fluctuation depends upon the ratio between the released volume and the total volume under compression, and also upon the extent to which the air has been previously compressed in transit through the blower. This occurs in the case of the single but not of the double impeller type here illustrated.

The theoretical relations which prevail in the case of a rotary blower having a fixed free area of discharge and no slip are identical with those already specified for the fan type operating within its capacity area, namely, the volume, and consequently the velocity, vary as the number of revolutions, the pressure varies as the square, and the power as the cube of the revolutions. But here the similarity ends, for in the fan the number of revolutions is an essential function of the pressure, while in the rotary blower they are entirely independent. In other words, material change of total pressure with the fan type can only be secured within the capacity area by change in revolutions, while with the rotary type great range in pressure is attainable at constant revolutions by merely varying the resistance.

Under conditions of constant speed and variable outlet or resistance, the performance relations of a theoretically perfect rotary blower are as follows, the effect of changes in temperature and density being disregarded:—(*a*) The volume is constant. (*b*) The velocity varies inversely as the effective outlet area. (*c*) The pressure varies inversely as the square of the outlet area, hence as the square of the velocity. (*d*) The power varies directly as the pressure.

But the mechanical necessity of clearance, and the consequent slip or backward leakage, affect these relations particularly as the conditions depart from the field of maximum efficiency. The slip is theoretically and in practice approximately proportional to the square root of the pressure difference between the atmosphere and the imprisoned air, that is, to the velocity which it creates. It therefore results that the volumetric efficiency decreases as the pressure increases.

Fig. 5 presents characteristic curves showing relative performance of a single impeller blower of the type illustrated in Fig. 3. The rapid drop in mechanical efficiency at pressures below ½ lb. is manifest.

The performance of a double impeller type, like Fig. 4, at different speeds and resistances, is illustrated by the curves in Fig. 6. Volumes and horse-powers are relative.

Under specific conditions of constant speed and resistance it might be possible to establish the superiority of one type or blower above the other, based primarily upon first cost and operative efficiency. But conditions vary as do blowers, which for commercial reasons are built in stated sizes from which selection must be made. Hence the problem is complicated, and the solution becomes to a considerable degree dependent upon the intangible factor of "adaptability." With no purpose of definition as to advantages or disadvantages, the characteristics of the two types operating within practical limits may be thus summarised and contrasted. With a fan blower the maximum pressure is determined by the number of revolutions; with a rotary blower it depends upon existing resistance or the weighting of the relief valve. The volume discharged by a fan blower is dependent upon the outlet area and the corresponding pressure; in the rotary type it is independent of both. The maximum power is required when a fan blower discharges against the least, and when a rotary blower discharges against the greatest, resistance. The fan blower automatically increases the created pressure as the opposing resistance becomes greater, until it equals the maximum pressure capacity of the fan. The volume, although coincidentally decreased, is rendered effective by the greater pressure, while the power is roughly proportional to the effective work. The rotary blower is likewise automatic up to the limit of pressure temporarily established by the resistance of the relief valve, but without material change of volume and with increase in power. Above the pressure limit set by the valve, air escapes to the atmosphere, and the power expended thereon has no useful effect. The weight and cost of a fan blower are far less, and the speed far higher than in the case of a rotary blower; at low pressures, the efficiency of the fan is superior, while at the higher pressures necessary in the cupola, the rotary type excels.

As the total head or pressure created by a blower represents the sole means of producing movement of the air, whatever portion of this head is consumed in overcoming the frictional resistance of piping and fuel reduces by just so much the amount remaining available for the production of velocity. The greater the ratio between the surface of a pipe, and the quantity, and the higher the

velocity, the greater is the resistance. Were the outlet in the casing of a fan blower to be made equivalent to the capacity area, the velocity and corresponding friction would be excessive. But in both the fan and rotary types the area of the outlet is such that the velocity of discharge seldom exceeds 3,000 ft. per minute. Even this is so great that material saving in power may be secured in a long pipe by making its area considerably in excess of the blower outlet. For instance, the frictional loss in 100 ft. of 10 in. pipe with 3,000 ft. velocity will be practically 1 oz.; while that in a 12-in. pipe, passing about the same volume at 2,000 ft. velocity, will be approximately ¾ oz.

If a certain velocity pressure is required at the point of final delivery, it is manifest that the blower, if in a distant location, must create a total pressure sufficiently in excess to allow for the loss by friction. A drop of a couple of ounces is not uncommon with an ordinary piping system.

The modern cupola furnace is typical of metallurgical progress in which conservation of heat has been secured by massing fuel and metal. As arranged in successive charges with a melting zone of maximum temperature beneath, the best possible opportunity is presented for the gradual ignition of the fuel and heating of the metal in their downward course.

It would at first appear that equal facility was provided for securing complete combustion, and that the quantity of air furnished might closely approximate the chemical requirements. But to secure the best results the volume is reduced in practice considerably below that theoretically required; of necessity incomplete combustion results. The conditions are closely similar to those in the blast furnace. The reason for this condition is to be found in the arrangement of the superimposed charges of fuel and metal with relation to the air supply, which necessitates passing through the lower charges all of the air required for those above. Although perfect combustion with an excess of air is thereby secured in the melting zone, the tendency of excessive dilution is to cool the gaseous mixture to a temperature even below that of the molten iron. Under such conditions less heat is transferred to the upper charges, because of the higher velocity and lower temperatures of the gases.

The air supply to a cupola is not, therefore, to be determined by the chemical requirements of the entire body of fuel, but by the excess which the lower charges are able to endure without disastrous cooling. The level of the ignition zone, and the completeness of combustion, are necessarily limited by this excess.

The introduction of two or more rows of tuyeres with large aggregate area has served to distribute the air admission, to reduce the cooling effect in the melting zone, to raise the level of the ignition zone, and to perfect the combustion. But a coincident—and otherwise beneficent—increase in the height of the charging door has still prevented the attainment of complete combustion, although a large proportion of the heat is utilised.

Authoritative chemical analyses of the escaping gases are exceedingly rare, but such as are available show that only about 50 per cent. of the carbon combines to form carbon dioxide. The balance escapes as an element of carbon monoxide having less than one-third of the heat value. In other words, only about two-thirds of the possible heat of combustion is utilised. This indicates a shortage of about 25 per cent. in the air supply.

The air supply to a cupola is usually expressed in cubic feet per net ton of iron melted. The amount necessarily varies with the melting ratio, the density of the charges, and the incidental leakage. Fair average practice is represented by the following:—

6 lbs. iron per lb. coke, 33,000 cub. ft. of air per ton of iron.
7 lbs. iron per lb. coke, 31,000 cub. ft. of air per ton of iron.
8 lbs. iron per lb. coke, 29,000 cub. ft. of air per ton of iron.
9 lbs. iron per lb. coke, 27,000 cub. ft. of air per ton of iron.
10 lbs. iron per lb. coke, 25,000 cub. ft. of air per ton of iron.

It is customary to provide blower capacity on a basis of 30,000 cubic ft., which corresponds to 75 or 80 per cent. of the chemical requirements with average coke, and a melting ratio of 7.5 to 1. This is evidently ample for any higher ratio.

Obviously, neither the rate of combustion nor the rate of melting can remain constant under the varying conditions within the cupola. In fact it is not fundamentally necessary that they should. But the blower is usually run at constant speed, and delivers uniform volume except as reduced by resistance. As a rule this reduction, which occurs only in the case of the fan, is relatively slight, for the volume (of which the velocity is a function) varies as the square root of the pressure. Hence, for instance, a 20 per cent. drop in pressure entails only about 10 per cent. loss in volume. Fairly constant pressure with

a more regular though not uniform volume is therefore to be expected in fan blower cupola practice, as well as a moderate melting rate due to delayed combustion, resulting from reduction in air supply coincident with increase in resistance.

For the purpose of illustration, extreme contrasts between the operation of a fan blower and a rotary blower are graphically presented in Fig. 7. These curves are based on tests reported by Mr. H. E. Field at the December, 1904, meeting of the Pittsburg Foundrymen's Association. The blowers, a No. 10 Sturtevant fan and a 33 cubic ft. Connersville rotary, were installed for alternate use in connection with a 54-in. lining cupola. So far as possible the charges were alike in weight and character in both cases. The scrap was heavy, and of such shape as to pack closely. These tests will be made the basis for some pertinent comparisons.

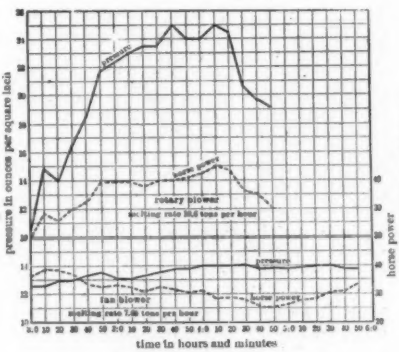
pressure in ounces per square inch
horse power
time in hours and minutes
rotary blower
melting rate 10.6 tons per hour
fan blower
melting rate 7.65 tons per hour

FIG. 7.—PERFORMANCE OF FAN AND ROTARY BLOWER ON A 54-IN. CUPOLA.

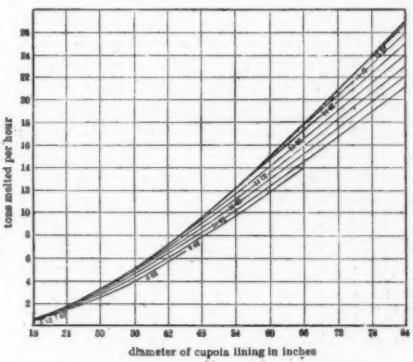

FIG. 8.—CUPOLA PERFORMANCE AT DIFFERENT PRESSURES.

Here are practically identical conditions of cupola and contents, but great contrasts in operation which show the effect of variation in air volume and pressure. With the fan blower the pressure was comparatively constant, the variation being between 12½ and 14½ ozs. in the wind box with an average of 13.6. The net power ranged from 25 to 38.5 horse-power, with an average of 31.2. The pressure with the rotary blower varied through the extreme range between 10½ and 25 ozs., while the average stood at 20.63. The variation in horse-power was between 19 and 45, the average being 35.8.

With the fan 28.84 tons were melted in 3.77 hours, at the rate of 7.65 tons per hour, while with the rotary blower 2.82 hours were required to melt 31.5 tons, at an hourly rate of 10.6 tons, an increase of nearly 40 per cent. in output. This reduces to a net input of 4.09 horse-power per ton melted per hour with the fan, and 2.98 horse-power with the rotary blower; an apparent advantage of 27 per cent. in favour of the rotary.

By far the larger quantity of air was discharged by the rotary blower, the rate of melting being closely proportional to the volume, as may be shown by a careful analysis of the tests. The rate is low for the size of the cupola, extremely so in the case of the fan, and is in part at least the result of excessive resistance presented by large pieces of scrap.

The results shown by these tests emphasise the possible effect of changes in the relation of the blowers to the cupola. Had the rotary blower been of smaller capacity such excessive pressures would not have been necessary to force the constant volume through the cupola; the power would have been decreased, and the duration of the heat prolonged, with probable decrease in the horse-power-hours per ton. Had the fan been run at higher, but not excessive, speed, to permit of passing a larger volume, which it was fully capable of delivering, the horse-power would have increased, the time decreased, and the power per ton per hour would certainly have more closely approached that required by the rotary blower.

A subsequent unofficial, but credible, test made upon the same cupola equipped with a No. 8 Sturtevant fan presents an

instructive contrast. The conditions were identical with those in the previous tests, except that a small amount of very light scrap was charged. The results showed 9.41 tons melted per hour, with an average pressure of 12.5 ozs. and a power expenditure per ton per hour less than 80 per cent. of that required with the No. 10 fan.

The preceding renders manifest the difficulties in the way of exactly proportioning blowers to the somewhat unknown conditions of their work, and likewise the futility of attempting to base comparisons of ultimate efficiency upon such limited experiments. In contrast thereto, it can be shown that a No. 10 Sturtevant fan, upon a 60-in. cupola, regularly melted 13.8 tons per hour, with an expenditure of 2.6 horse-power per ton, and a No. 8, upon a 42½ in., required only 2.9 horse-power per ton upon a total output of 6.46 tons per hour. And likewise that rotary blowers of identical size and quality have shown results both inferior and superior to those here reported.

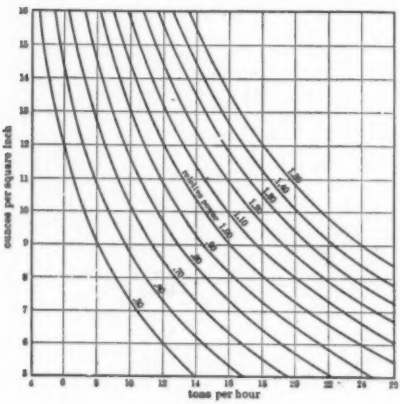

FIG. 9.—ROTATIVE POWER FOR DIFFERENT PRESSURES AND MELTING RATES.

The higher speed of melting, which because of its ability to overcome excessive resistances, may be maintained by the rotary blower, is universally recognised, as is also the increased time thus rendered available for moulding before the first iron is tapped. But the greater pressure incident to the higher rate is much more severe in its cutting effect upon the lining, while the value of the time gained for moulding depends upon individual foundry conditions. The superior mechanical efficiency of the rotary type is, to a greater or less degree, offset by much lower first cost and fixed charges on the fan. The necessity of providing power capacity greatly in excess of the average in the case of the rotary blower is not to be overlooked. Neither is it to be forgotten that the brief duration of the heat reduces the difference in annual expenditure for power to a relatively unimportant item. For instance, under the exceptional conditions in the tests shown in Fig. 7, the daily difference in electrical horse-power-hours input was only 20.3. On a basis of 10 hours per day this equals only 2 horse-power continuously exerted.

Theoretically, for otherwise constant conditions, the following relations hold for cupolas and melting rates within the range of practical operation: (*a*) The melting rate with constant volume varies directly as the square of the diameter, that is, as the cross-sectional area of the cupola, and directly as the volume, as the square root of the pressure, and as the cube root of the power for a given cupola. (*b*) The volume varies inversely as the square of the cupola diameter for a given melting rate, and directly as the melting rate for any cupola. (*c*) The pressure with a given cupola varies directly as the square of the volume, that is, as the square of the melting rate, and as the depth of the charges for a given melting rate. (*d*) The power with a given cupola varies directly as the cube of the melting rate, and as the cube of the square root of the pressure, and directly as the pressure for a given melting rate and any cupola, *i.e.*, inversely as the fourth power of the diameter for a given melting rate. (*e*) The power per ton per hour (the operating efficiency) for a given cupola varies directly as the square of the melting rate, that is, as the pressure; and for a given melting rate directly as the rate for a given pressure, directly as the pressure and inversely as the fourth power of the diameter. (*f*) The duration of the heat for a total output for a given cupola varies inversely as the square root of the pressure.

It is no longer considered creditable to secure the largest possible output from a given cupola; it is better practice to use a larger cupola for the same output. The tendency is distinctly in the line of more moderation, both because of higher ultimate operating efficiency and the improved quality of the castings. Figs. 8 and 9 clearly indicate the economy

of such a course. It is to be noted that although the curve of maximum output in Fig. 8 is freely drawn through points representing good current practice, it conforms closely to the relations expressed above, *i.e.*, that the melting rate varies directly as the square of the diameter. Wide variations are to be expected in individual cases. The maximum pressures capable of maintaining the corresponding melting rates under proper conditions vary with the diameter and the height of the cupola, as well as with the proportions of the charges. Other melting rates are plotted in proportion to the square roots of lesser pressures for corresponding cupola diameters. It is, however, because of the great variety in conditions that the values indicated by this or any other set of curves are purely relative and cannot be made directly applicable to cupola practice in general.

The power economy of low pressures and melting rates is clearly shown by Fig. 9. The lines of unit expenditure have been arbitrarily fixed in the middle field of good practice.

The actual melting range of a cupola is ordinarily between 0.6 and 0.75 ton per hour per square foot of cross section. The limits of air supply per minute per square foot are roughly 2,500 and 4,000 cubic ft., with the mean as representative of fair practice. The possible power required varies even more widely, ranging from 1.5 to 3.75 horse-power per square ft., corresponding respectively to 2.5 and 5 horse-power per ton per hour for the melting rates specified above.

Current practice can only be expressed between limits, as in the case of Table 3. Therein is given the ordinary range of the different variables for stated cupola diameters. The specified pressures prevail most extensively in recent installations. In so far as it is possible to determine the melting rate and the necessary pressure therefor, the power may be roughly calculated from the theoretical requirement of 0.27 horse-power to deliver 1,000 cubic feet per minute against 1 oz. pressure. The power increases directly with the pressure, and is practically dependent upon the efficiency of the blower. This will range from 50 to nearly 70 per cent. in a good fan installation, and up to a possible maximum of 90 per cent. with a first-class rotary blower equipment. The drop in pressure due to an extended system of piping must not be neglected in such calculations.

The trend toward lower pressures in the cupola is reflected in current air furnace practice. The high pressure fan blower with small volumetric capacity has been superseded by the volume fan having ample capacity at much lower pressure. Both volume and pressure are dependent upon the quality of the coal and the rate of combustion. The deep fire lends itself to complete utilisation of the air supply, with minimum excess and maximum temperature. Both under- and over-grate supply pipes should be of ample size to avoid excessive loss by friction, and the pressure should be the lowest which, with a properly proportioned blower, will pass the required volume. This pressure need not exceed 2½ ozs. per square in., and under good conditions should be considerably less. The volume delivered beneath the fire may be kept well down toward the theoretical requirements, not exceeding 200 to 225 cubic ft. per pound of coal.

In the crucible furnace still lower pressures prevail, but the air supply is not as effectively utilised.

Flexibility in the application and operation of a blower is sufficient to permit of approximation in its size. Unfortunately its size number conveys no idea of its capacity, although rotary blowers are secondarily classified by volumetric displacement. The manufacturer's recommendation, checked by the purchaser's experience, must generally serve as the simplest rule of selection.

TABLE 3.—*Range of Performance of Cupola Blowers.*

Diameter inside lining. Inches.	Capacity per hour. Tons.	Pressure per sq. in. Ounces.	Volume of air per minute. Cubic ft.	Horse-power.
18 ...	0.25- 0.5	5- 7	150- 300	0.5- 1.5
24 ...	1.00- 1.5	7- 9	600- 900	2.0- 6.0
30 ...	2.00- 3.5	8-11	1,200- 2,000	5.0- 15.0
36 ...	4.00- 5.0	8-12	2,200- 2,800	10.0- 23.0
42 ...	5.00- 7.0	8-13	2,700 3,700	12.0- 32.0
48 ...	8.00-10.0	8-13	4,000- 5,000	18.0- 45.0
54 ...	9.00-12.0	9-14	4,500- 6,000	22.0- 60.0
60 ...	12.00-15.0	9-14	6,000- 7,500	30.0- 75.0
66 ...	14.00-18.0	9-15	7,000- 9,000	35.0- 90.0
72 ...	17.00-21.0	10-15	8,500-10,500	45.0-110.0
78 ...	19.00-24.0	10-16	9,500 12,000	50.0-130.0
84 ...	21.00-27.0	10-16	10,500-13,500	60.0-150.0

GEO. G. BLACKWELL, SONS & COMPANY, LIMITED, of The Albany, Liverpool, have erected at considerable cost at Garston a new metallurgical works, for the manufacture of alloys and metals, and particularly tungsten metal, for the steel trade.

A VOLUMETRIC STUDY OF CAST IRON.*

By Henry M. Lane.

Engineers in dealing with metals are accustomed to speak of the percentage of impurities present with reference to the weight of the entire mass and the impurities. As a rule no attention is paid to the relative volumes occupied by these impurities, and this neglect probably accounts for many of the seeming contradictions in the behaviour of alloys.

Cast-iron in its various forms may be considered as an alloy. By weight it rarely contains more than 94 per cent. metallic iron or pure iron, and in some cases scarcely more than 90 per cent. Many attempts have been made to account for the apparently disproportionate effect produced by the addition af comparatively small amounts of impurities. If, however, we consider the relative volumes occupied by these impurities by themselves, and also the volumes probably occupied when in combination with the cast-iron, we obtain an entirely new light upon the subject.

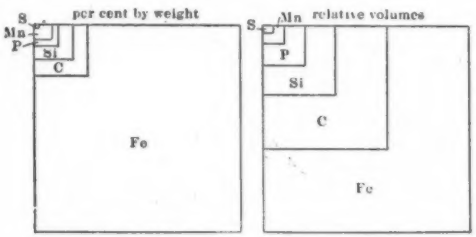

Fig. 1.

An ordinary foundry iron contains 2 per cent. of silicon, 0.40 per cent. of sulphur, 0.70 per cent. phosphorus, 0.70 per cent. manganese, and 3.50 per cent. carbon; or a total of 6.94 per cent. of the principal so-called impurities. Some of these elements we have been familiar with in their pure state for a long time; such as sulphur, phosphorus, and carbon. Manganese is a metal very closely related to iron, and having nearly the same specific gravity, and hence when it is alloyed with iron it changes the volume of the mass but little. Some of the other elements, however, behave very differently. Pure silicon has a specific gravity of less than 2, while iron has a specific gravity variously reported from 7.77 to 8.0. This means that a given weight of pure silicon occupies four times the volume of a given weight of iron; therefore we may call the volume factor for silicon, 4. In like manner we find that sulphur occupies more than four times the volume of iron, and its volume factor would then be 4.07. The volume factor for phosphorus would be 4.44, and the volume factor for manganese 1.01.

Carbon in the graphitic form, which is practically the condition in which it occurs in grey cast-iron, occupies more space than any other of the constituent elements, and its volume factor would be 6.79.

Using these factors, we may make some very interesting calculations concerning some of the more common iron mixtures, and these will lead us to an understanding of a number of the peculiarities of castings.

Table 1 gives the percentages by weight and by volume of the elements contained in No. 2 foundry iron, in stove plate, machinery iron, and annealed malleable iron. Some explanation is necessary concerning the different mixtures. Each of these analyses was taken from an actual analysis of a standard brand or a casting. In the case of the stove plate the percentage of phosphorus is lower than that often found. The silicon is lower than that which occurs in many stove plate castings.

The machinery iron is also a rather low silicon mixture. Mixtures somewhat low in these elements were chosen for a purpose, on account of the fact that it was not desired to show the most radical limits, but rather the average. In the case of the malleable casting, the percentage of carbon present of course varies greatly between the surface and the interior of the casting.

Believing that the mind sometimes recognises these differences more keenly through the eye when they are expressed graphically, the diagrams shown in Figs. 1,

* Presented at the New York Meeting (December, 1907) of the American Society of Mechanical Engineers.

2, 3, and 4 have been prepared. Fig. 1 illustrates the relative amounts of impurities in No. 2 foundry iron by weight and by volume. The squares at the left represent the relative amount of the different elements by weight, while those at the right represent the proportion of the

and figures show that the stove plate has over 40 per cent. impurities by volume.

This has been very nicely proved by an actual demonstration in which as much of the iron as possible was removed from the castings by a long pickling in dilute hydrochloric acid. The pickle was a wash used

TABLE I.—*Percentages of the Elements in Various Classes of Iron, by both Weight and Volume.*

	No. 2 Foundry Iron			Stove Plate.			Machinery Iron.			Malleable Iron.		
	Per cent.	Factor.	Per cent. volume.	Per cent.	Factor.	Per cent. volume.	Per cent.	Factor.	Per cent. volume.	Per cent.	Factor.	Per cent. Volume.
Si	2.00	4 00	8.00	2.47	4.00	9.88	1.30	4.00	5 20	0.70	4.00	2.80
S	0.04	4.07	0.16	0.09	4.07	0.37	0.05	4.07	0 20	0.04	4.07	0.16
P	0.70	4.44	3.11	0.51	4.44	2.26	0.43	4.44	1.91	0.15	4.44	0.66
Mn	0.70	1 01	0.70	0.26	1.01	0.26	0.22	1.01	0.22	0.20	1.01	0.20
C	3.50	6.79	23.76	4.19	6.79	28.45	3.50	6.79	26.48	3.00	6.79	20.37
Total	6.94	—	35.73	7.52	—	41.22	5.90	—	34.01	4.09	—	24.19

elements by volume. Fig. 2 illustrates the amounts of the elements in stove plates. The figure at the left shows the amount of the elements by weight, while the areas in the figure at the right indicate the proportion of the different elements by volume. Note that the area occupied by the manganese in the two diagrams is practically the same, due to the fact that the specific gravity is about the same as

for dipping the castings into previous to nickel-plating. Some castings fell by accident to the bottom of the vat and remained there several months. When they were removed it was found that they were exceedingly light; and while they looked exactly like iron castings, they were brittle and very difficult to handle without breaking. An analysis showed that by far the largest portion of the iron had been re-

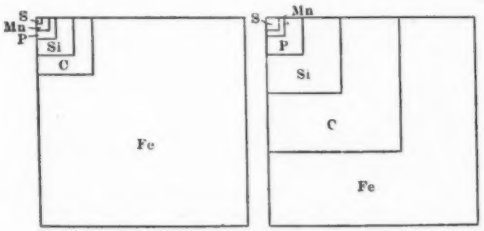

FIG. 2.

that of iron. Fig. 3 shows the relationship between the weights and volumes in machinery iron. The diagram at the left shows the percentages by weight and that at the right the percentages by volume. Fig. 4 illustrates the relationship between the percentages by weight and volume of the constituents of annealed malleable iron. The diagram at the left shows the percentages by weight and the one at the right the percentages by volume. On the left in each case the areas represent the percentages of different impurities by weight, while on the right the areas represent the relative volumes. These diagrams

moved by the pickle, and hence the remaining constituents formed simply a skeleton or sponge.

This volume study also offers an explanation as to why this long annealing and removal of the carbon weakens the casting. In the first place, if the carbon could be taken from the malleable casting without any other change, we see that it would result in about 20 per cent. of the bulk of the casting being removed. In other words, the annealed malleable casting would contain 20 per cent. of voids. These open spaces would certainly not strengthen the casting, as it stands to

reason that the carbon which formerly occupied them would certainly support the iron about it to some extent. This carbon as it exists in the annealed casting is undoubtedly highly compressed, as is attested by the expansion of the iron due to the change in the carbon, and in this compressed state would assuredly form a support to the surrounding metal.

But the carbon cannot be removed without involving other changes. If this carbon were to be removed by oxidation, it is certain that some of the iron would also be oxidised, and that the iron oxide thus formed would fill some, if not all, of the spaces left by the carbon. The iron would therefore be weakened not only by the removal of the carbon, but by the oxidation of a portion of the iron. This undoubtedly explains why a malleable casting which has been heated just above the recalescence point and held there merely long enough to convert all of the carbon from the combined to the temper form, without the removal of any of the carbon, is in its strongest condition.

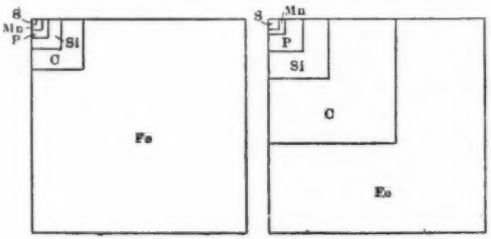

FIG. 3

In the case of stove plate, where the elements constitute over 40 per cent. of the volume of the metal, we can readily believe that the extreme fluidity of the iron is to a large extent due to the great percentage of impurities present. It will be noted that the phosphorus factor is high; and hence high phosphorus, which has always been found to produce fluidity, would be expected to exert a great influence, on account of the large volume which it occupies.

Of course, the phosphorus is undoubtedly combined chemically with the iron, hence there is probably an error in considering it in its elementary or pure condition, but in the absence of exact data on this point it is impossible to state just how this and other elements do affect the mixture which we commonly call cast-iron.

In order to bring this volume matter out very clearly, Fig. 5 has been arranged, showing the difference between the relative percentages in Swedish iron and in stove plate. In each case the large square represents 100 per cent. In the left-hand figure the small square in the centre represents the impurities in Swedish iron by weight and the square surrounding it the impurities in stove plate by weight. In the right-hand figure the two inside squares represent the volume of the impurities in Swedish iron and the volume of the impurities in stove plate. From this we can readily see why the comparatively soft and ductile Swedish iron is changed so completely by the introduction of only about 7 per cent. by weight of impurities.

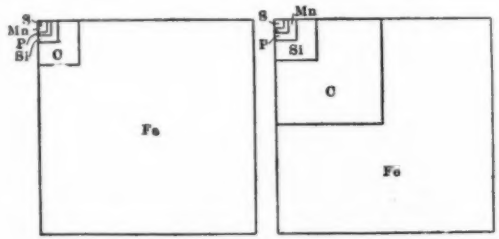

FIG. 4.

The foregoing facts have been confirmed by a number of cases which have come

under the observation of the writer, or have been related to him by other engineers, and the matter is here presented in the hope that someone else will take up the investigation and carry it much farther.

The fact that the impurities in cast-iron take up such a very large proportion of the volume is the reason why we have thus far been unable to apply the microscope to cast-iron with the same gratifying results which have followed its application to the metallurgy of steel.

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SOME LIMITATIONS OF THE MOULDING MACHINE.*

By E. H. Mumford (Philadelphia, Pa.).

The recorded art of moulding by machinery is far older than that of the steam engine, and there lacked only to-day's demand for multiple parts and the facilities for developing the art to have put it where it is now a hundred years ago. Thus, just as soon as a stripping plate was needed, it was "invented"—more than a hundred years ago, and as soon as a foundryman felt the vibration of a pneumatic hammer he used what we now call a "vibrator" to help draw a guided pattern.

About twenty years ago S. Jarvis Adams, in Pittsburg, jolt-rammed moulds for pipe balls and wagon axle boxes; yet even to-day the modern jolt-ramming machine at an exhibition attracts a crowd of foundrymen amazed at its novelty.

It was their long years of experience with the subtle and elusive behaviour of green sand in the presence of melted metal, in the secret intimacies of the closed mould, that led Union moulders some sad years since to scoff at moulding machines and to foretell their doom unaided by the moulder's skill. And moulding machines have failed—machines of much ingenuity—heralded as labour-savers, because they did so many things done before by hand. These machines have failed because of too many opportunities for failure in a single enchained mechanism. Kipling's "Interdependence absolute" of McAndrew's idol engine is not for foundry use. Before the heartless biting cynicism of foundry ethics many a clever engineer has come to grief. Where melted iron rules and sand intrudes with every lubricant, refinements of machine design may not be much elaborated. And so, though the Patent Office is filled with ingenious moulding machines, most of them have failed, as the moulder prophesied, while the art of machine moulding has steadily progressed. It is still eliminating the machines which bring the sand in from the yard, temper it, riddle it, and ram it,

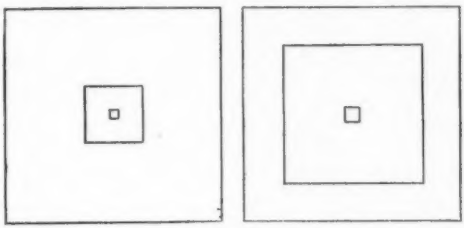

Fig. 5.

pass themselves their flasks, sand frames, sprue cutters, and other accessories, draw their patterns, deliver the finished moulds and have only to be restrained from setting the cores.

It is not speed of production of blocks of sand which look like moulds and which in the halcyon days of "demonstrated" machines often passed as such and sold the machine, even while the "demonstrator" walked around upon them, which in 1907 proves the machine. The present-day moulding machine must take what the foundry gives it and turn back what the foundry wants—moulds in quantity and of quality excelling in economy of production the product of hand labour in castings, or it gets no welcome there.

But there is another reason for the markedly gradual and cautious development of the moulding machine. It is the infinity of shapes and kinds of patterns around which green sand must be rammed with uniformity of mould surface, and the necessity of arranging some more or less universal method of withdrawing these

* Presented at the New York meeting (December, 1907) of the American Society of Mechanical Engineers.

patterns from the rammed sand without in the least degree displacing it.

Another limitation to the exploitation of moulding machines to make moulds as bricks are made lies in the fact that these machines, unlike those for making bricks, do not finish their work. Sand and flasks must be supplied to the machine and castings must be poured and cooled and shaken out. It would not be difficult to design a machine which would mould, for example, 200 shoes per hour, and such machines have, in fact, been built. Each machine, however, would call for 5,000 lbs. of sand and as many lbs. of flasks to be delivered to it and carried away from it again every hour. Even then the moulds are in halves and without cores set; 200 cores must be set and 100 copes closed on every hour. To keep the "floor" from gaining on the foundry, 5,000 lbs. of hot metal must be poured from double hand ladles every hour, which work would keep from four to six men busy pouring and shifting weights. As many more men would be required to shake out and remove hot castings, and at least two more to get the flasks off of the floor again. Only a little foundry experience will prove that this situation is impossible. The elaborate foundry structures for dropping both sand and castings through the floor still leave the labour of setting cores, handling and closing moulds, pouring and shaking out to be performed. In fact, we are far from the realisation of a moulding machine which will turn out castings, as do the type casting machines, and all machines which cast mildly hot metal in chills, and which may not be called moulding machines as their moulds are already prepared. The mould which melted iron will not destroy, and which will not exaggerate unequal cooling of the casting surface, with resulting evils, is no nearer our commercial use than is the Philosopher's Stone, and, until it is, the moulding machine, delivering only incomplete sand moulds, will still invoke the genius of the designers who know where to limit its functions, and the ignorance of those who do not.

Limitations of Machine Functions.

Ramming.—Soft Deep Sand.—Sand will flow only slightly under pressure, hence pressure and blow ramming machines fail to reach deep parts because shallower parts absorb the pressure. Sand, especially in pressure ramming, is subjected to great friction in its movement down the sides of patterns and flasks—hence even directly vertical pressure over deep parts does not ram them down all the way.

Ram-offs.—After sand is partially set in a mould, by pressure or other means, it has taken the shape of the pattern, and if it is moved, it carries this pattern shape—as of a corner—with it. Thus a blow of a hand rammer at one side of the sand, compressed by a previous blow, shifts that partially rammed sand aside, and generally away from the pattern.

In jolt ramming machines a peculiar ram-off effect occurs at every convex corner of a pattern. This is due to previous jolting having set the sand over the pattern at the corner, with the result that little of it can follow out and down past the corner to take the place of the deeper sand which the later blows of the jolting cause to settle down the more or less vertical sides of the pattern. The result is a zone of soft sand just under the pattern corner.

Still another failure in ramming, in the nature of a ram-off, occurs in what is coming to be known as the "gravity" machine, though it is no more entitled to the term than the jolt-ramming type, gravity alone being employed in both machines. Allusion has been made to the upward looking convex corner of the pattern around which it is hard to get the sand to flow. In the jolt-ramming machine the sand is placed in pockets, and the long pattern sides prior to ramming, while the sand in the "gravity" machine falling in bats, tends to shed off the corner more than sand previously placed around it; and this has led to constant failure in the past in this very old method of ramming. Moreover, the sand, falling from a fixed height, tends to ram all parts of the mould equally hard—which has the especially undesirable effect of making copes as hard as drags. In fact, it seems worth mentioning here that what is called "uniform ramming" is not a desirable feature in moulding machines. The more sand density can be varied the better.

In vibrator frame machines—called such, though the same term may be applied to any machine using an undivided pattern with extensions from the patterns to guides outside the mould—the effect of ram-off is commonly produced by springing of the unsupported pattern during ramming, it being immaterial whether the movement be in the sand or the pattern.

Barred Flasks.—Flask bars have been a limitation more or less serious in all moulding machines. Taking all kinds of bars into consideration, including those which spring under jolt or pressure ramming, there are none which do not give trouble, or cause loss of time, if we except the so-called "floating bars," and even

these must be nicely proportioned to depth of sand, etc.

Pressure-ramming machines must employ special ramming blocks cut away to clear bars. Jolt-ramming machines require that the bars shall be very thin, and yet not spring, for if a bar shakes off the contact of the sand and the frictional bond between the sand and the bar is destroyed, the bar merely aggravates the tendency of the sand to drop from the flask, but cutting it into channels and unsupported blocks.

The writer knows of only one bar that will hold the general mass of sand after the sand has actually separated from its under edge. It is one which has been designed specially for jolt-ramming and tested with complete success, and it permits the sand to settle away from it in the cope while keeping the mould from "coping," as the runner fills up; for it holds the sand down as well as up. The floating bar, whose action is ideal if its descent into the sand under it is properly controlled, is an element in what is known as bottom-ramming, and the action is the same whether the bar only, or the bar and the flask which holds it, moves toward the pattern in ramming. This is the only form of flask bar which is not, even theoretically, a limitation to ramming by machine.

Ramming Patterns Down or Sand Up.—It is impossible to ram sand up into an inverted pattern, as is required in making a drag mould, without rolling. The pattern must first be filled and surrounded with sand. Rathbone did this first in 1905. He was using a blow-ramming machine, with an inverted drag pattern on a match board for producing multiple moulds, and found that the projection of the unrammed sand against the pattern an instant before ramming—a result incidental to the apparatus he used—accomplished what had not been done before.

Machine Limitations in Pattern Drawing.

Mismatch.—It is assumed that patterns and flask pins are accurately fitted; this match is caused by the following four conditions:—(1) Cope and drag parts of the pattern on separate carriers—nothing but a miracle can insure accurate match, for all the errors due to misfits of the dowels, etc., enter in, as they do not when the same rigid piece carries both parts. (2) The pattern carrier separated from the part of the machine containing the flask pins. An apparent exception to this is the ordinary stripping plate machine, when patterns are new. In this case, the pattern may move out of match, but the new stripping plate with flask pins in it, in sliding over them forces them into place. It goes without saying that the edges of both the stripping plate and the pattern suffer in consequence. (3) Lack of support of joint surface during pattern drawing downward causes sagging of joint.

If from any cause the two point surfaces of a mould are not perfectly flat, or, if not flat, perfectly inversely similar, such a joint will "creep" out of match in closing. For this reason mainly, better matched moulds are obtained from stripping plates, which support the point during pattern drawing.

In the first use of vibrators on machines, the slight lateral freedom of the pattern carrier necessary with reference to the mould was secured by the proper freedom of a match plate on the flask pins. In the endeavour to improve vibrator action, the pattern carrier was separated from the part containing the flask pins. The idea was that the agitation and dropping of the sand while drawing patterns down would be thus avoided. While this was, in a measure, accomplished, the clearances thus introduced allowed the patterns to shift out of match during ramming, and led to the introduction of untrustworthy automatic locking devices dependent upon springs.

Bottom boards and match boards springing under ramming produce the amorphous joints last referred to by causing convex drag joints, if the ends of boards have sprung into moulds, and concave drag joints if the centres have sprung in. A prolific source of this failure in machines is the use of skids instead of flat tables in pressure-ramming machines. For example, with 2½ in. skids, placed 10 in. apart, the centre of the board of a mould, 14 in. long, will be sprung in, producing a concave drag joint; while the ends of the board of a mould, 28 in. long, will be sprung in and a convex drag joint result.

Broken Corners.—Stripping plates know no such failures, for their essential function, as indicated by their French name, "*peignes*" (combs), is to comb the sand along the edges of the pattern. But in those machines which employ vibrators to start the edges of sand, three things are necessary: (1) Clean and well drafted edges of the patterns. (2) Absolutely straight movement of these edges relatively to the sand, or *vice versâ*. (3) Flasks undistorted by clamping or otherwise.

In the matter of clean joint edges, an interesting detail has within the last few years been developed. Split patterns on match plates are frequently hollowed out to save weight and metal, and all patterns have more or less air space between them

and the plates. Mr. Walker, at Erie, found that at the moment of ramming by pressure, the air under the patterns is compressed to the 30 to 50 lbs. pressure of the mould, and that, to effect this compression, the very damp air in the unrammed sand is forced under the pattern—then, immediately, when the pressure is taken off of the sand, this imprisoned damp air issues from this hollow under the edges of the patterns next to plate. This constant breathing in and out of wet air causes wet corners, to which the sand adheres. This has led Mr. Walker to adopt the plan of sweating his patterns on a tinned plate. The little fillets of solder which run up along the pattern edges help the pattern draft very materially.

The slightest touch of a pattern on the sand corner that is leaving takes at least a little of that corner with it. An illustration of this has been the absolute failure of what is known as the vibrator frame, and of vibrated solid patterns on chain link and saddlery hardware. The hand moulder, rapping his pattern through the cope into the closed joint of his mould and then, with practised hand setting his patterns in the exact centre of the enlarged sand chamber he has formed, lifts his cope clear and clean, while the vibrator moves the pattern very little. The guide on the flask pins, though true, is vibrated by the rocking in hand lifting, the sand corners are sure to touch somewhere, and just there the sand is either torn up or knocked down, depending upon whether the pattern is drawn up or down.

Untrue Draft.—I have just mentioned the rocking of a mould or pattern by hand as fatal to clean draft. Any divergence from a line of draft normal to the joint surface of the mould, or a line predetermined, is equivalent to vitiating the "draft" given the pattern by its maker and setting up a back draft. Yet these conditions arise in what are known as rock-over machines, which draw their patterns from moulds lying on tilting bottom boards.

Flasks Sprung.—Hand-rammed rock-over machines retain a weakness which every experienced moulder would avoid. The flask—often a very shallow wooden flask—is edge-clamped to the pattern board. The springing and subsequent recovery of the flask deform the joint of the mould unless the hand-moulders' method of wedging the joint is adopted. Mr. Pridmore foresaw this difficulty when he first began to build rock-over machines years ago, and patented clamps which prevent the springing of the flask.

It is an axiom in machine moulding that all pattern draft must be taken from the mould joint, and that this joint must be maintained without deformation until the mould is closed.

Sizes and Shapes of Moulds.—Moulding machines are now in a position to say to the trade that the mere size of the mould is no reason for not making it by machinery. This is very evident in the case of hand-ramming machines where the problem of furnishing from 15 to 100 lbs. ramming pressure to every square inch of area is not encountered, and in the most widely known hand machines, where the ends of the frames which carry the stripping plates are left open, any length of flask within the width capacity of the machine may be accommodated, provided the length is not sufficient to cause too great an overhang.

Until this year, America has not known familiarly a complete moulding machine that would handle for both ramming and drawing patterns any size or shape of mould for which it had ramming capacity. Consider for a moment what it has meant to the introduction of moulding machines that a power machine has been used for, at most, three or four sizes of flasks, the only latitude being in width, and this limited to a narrow maximum. To illustrate how easily satisfied the foundry trade is, let me say that for years several machines of different sizes have been sold to foundries in which a single size, and often a single machine, would have answered the purpose. And the only arguments advanced therefore have been: (1) It will not do to have too large a top on a machine, as the projection beyond the flask catches sand. (2) The flask pins in the machine require that the pin dimension of the flasks should be constant.

Our technical Press has lately been filled with descriptions of a French moulding machine and its equally interesting pattern equipment, which is, without any question, the most brilliant work in machine moulding in a hundred years of development. The able Frenchmen who have evolved this mechanism have christened it "Universal," with an intensity of meaning characteristic of the deep thought which has produced it.

As to the machine itself, what has it done? It has emasculated the potent arguments which have filled our foundries with polyglot machines, since no part of the French machine projects beyond the flask to catch sand, no matter what the size or shape of the flask, and the flask pins are not in the French machine. It is not necessary here to describe this re-

markable machine and its fit companions, the Plaques Modêles and Clichés Tables, which promise to reduce our moulding machine pattern costs from 50 to 90 per cent. Very complete descriptive matter from one of the inventors, Mr. Ronceray, has already been published.

The writer will enumerate the limitations of the moulding machine as known in America to-day, which are eliminated by the new machine moulding of France.

Ramming.

Soft Deep Sand.—All the French machines may be fitted, at a trivial cost, with Double Serrage—an appliance for double-ramming. This is simply an auxiliary plunger under the mould table of the machine, set quickly to stop gauge, to which are attached what we call, in the United States, "stools." While the main ramming pressure is on, these stools, which have receded to allow a given amount of sand to enter the pocket or cavity, are run against the stop gauge and the soft sand is made just hard enough. This procedure is general from Tupper grate bars to deep and intricate green sand cores in automobile castings.

Ram-offs.—Only a single application of pressure is made, and deep vertical sides are rammed from the opposite direction so that no "ram-off" can occur.

Mismatched.—As the flask pins are not in the machine—though they are drawn by the machine—the match is made and maintained in the foundry so that, with full responsibility, the foundry may also have credit for matches more perfect than heretofore.

Broken Corners.—As stripping plate patterns made by the French process are as cheap as the various forms of vibrated patterns heretofore known in America, it becomes much more practicable to adopt stripping plates. Broken corners, such as have to be considered in vibrated patterns, are unknown to stripping plates. In fact, except for the cost of the latter, there would never have been use for vibrators in connection with moulding, except as adjuncts to stripping plates. This is even true of patterns drawn up especially, as in the inverting French machines, the stripping plates or stools follow the sand down automatically.

Untrue Draft.—There can hardly be truer pattern draft than that guided by the same plunger which has done the ramming, as is the case in all the French machines of the rotary or inverting type. The only necessary precedent is that the ramming, or bottom board which has been forced into the flask, if such a one is used, shall have an even seat when the mould, which is being lowered on the inverted ramming plunger, is leaving the pattern. The slightest difficulty from this source is easily removed by three-point bearings.

In the French machines of the fixed type, the pattern draft datum is taken from the mould joint itself, inasmuch as the columns which raise the stripping plate and the half mould upon it have adjustable tops, which are set at the start to conform to the exact surface of the mould.

Flasks Sprung.—Since no clamps are used, there can be no springing of flasks from this cause. Furthermore, I would here mention an innovation illustrating the national differences in everyday practice in the moulding methods of two countries, in even these latter days of constant interchange of ideas.

The French use round flasks as commonly as we do square ones. They use snap flasks hardly at all, and yet they obtain from solid flasks what we know only as snap moulds. When it is stated that 220, 21 in. round "snap" moulds are produced in a day by two men from "solid" flasks, I know that many will ask "How?" The moulds are made as moulds in 21-in. round flasks would ordinarily be made, except that very thin "binders," hoops of steel only $\frac{1}{32}$ in. thick, are employed. The drag mould is then set upon a plate on the round table carried by an assembling machine, the table and plate being a little smaller than the inside of the flask. This plate serves as a bottom board. The cope mould is placed above the drag, over long pins common to both parts, so that the match is absolute. The cope flask being locked so that it cannot rise, the plunger rising against the drag carries it up to the cope, closing the joint, and then the continued ascent of the plunger forces the sand bodily up out of both flasks, and we have the strongest shape possible of a snap mould held by binders—a cylindrical one.

Thus, by methods radically new, we are introduced to a system of machine moulding which has profited by a study of the limitations of previous machines. Not all of the limitations I have named nor others not mentioned, because so numerous, have yet been surmounted; but Paris at present holds the prize for the greatest advance.

So complicated and so varied are the demands upon the foundry moulding machines, that, unattractive as the hot, dusty foundry is to engineers, I suggest that to-day there is no more promising realm of thought to attract the genius of the machine designer, who has had the opportunity to learn by hard experience what a moulding machine can, and what it absolutely cannot do.

POWER SERVICE IN THE FOUNDRY.*

By A. D. Williams, Junr. (Pittsburg, Pa.)

In view of the progress that has been made in other mechanical lines, it is remarkable that the foundry of to-day remains much as it was in the past. Since it plays a most important part in the industrial economy of all metal manufacturing plants, either directly or indirectly, it merits better treatment than it has received.

Some years ago the chemists turned their attention to the foundry, and the results are seen in the replacement of empirical by scientific methods of mixing and melting, and in the heat treatment of castings. The concrete results of their experiments are apparent in a reduction of the percentage of castings lost, and the production of castings better suited to the purpose for which they were made.

The mechanical end of the foundry offers an interesting field for the engineer, not only in the designing of the castings, but in the invention of ways and means suited for their production. To a degree this work has been started, but has been confined to the production of moulding machines and appliances, and the greatest progress has been made in those foundries which are devoted entirely to special lines of work, in which large quantities of castings of the same or similar characteristics are turned out. In the foundry whose output comprises a large variety of castings, ranging from bench work to heavy housings and bed plates, the methods in use to-day differ but slightly from those of twenty years ago, the improved facilities consisting mainly in the provision of a better crane service for handling the work.

The principal reason why power is not used to a larger degree in foundry work arises from the fact that few foundries are so designed that the means at hand can be used to the greatest advantage. Machine moulding is limited in its applicability to castings which can be turned out in sufficient quantities to justify fitting up for them. Power can be used for nearly all classes of green sand work, and once the proper fixtures for its use are available it will be found of service in many ways. The foundry crane of to-day is a vast improvement over that used in the past, but in the matter of improved crane service, not only the foundry, but the machines shop as well, suffer a diminished output per square foot of floor area. Moulding machines, cranes, chipping chisels, grinders, the blower, and the cupola elevator are the usual limit of power service in the foundry. A few columns, roof trusses and siding, a crane with its runway, possibly a few jib cranes, a cupola with its charging platform, elevator and blower, some core ovens and a little industrial track are dumped down in a vacant lot and called a foundry. A rough carpenter knocks a few flasks together, and sand is spread on the floor; just as soon as some pig-iron, limestone and coke, etc., are delivered the plant is in running order. The machine shop is usually very carefully designed.

The crane service of a foundry is its vital point. There must be crane capacity to handle the heaviest piece to be made, but at the same time it is necessary to bear in mind the fact that there are a number of medium and a greater number of light pieces to be turned out for each heavy casting. A single crane can serve only one floor at a time; the others must wait, in fact two or three floors are often waiting on the crane, and must take their turns after the crane has finished handling a load of less than one-sixtieth of its capacity. This scene is not uncommon in the foundry, and that they were "waiting for the crane" is often the excuse for moulds left over for the next heat.

The bridge travelling crane is a most useful machine, but it cannot be in two places at the same time, and as yet no successful method has been devised by which two of them can pass each other either on the same or on different levels; in fact, the use of bridge travelling cranes on two levels only adds to the expense and does not supply any advantages over those cases where all of the bridge cranes are on the same level. The jib crane is limited in usefulness, as it cannot serve floors outside of its radius, but a number of light column jib cranes, arranged so that they can be set up and transported from place to place as needed, are very serviceable. This can be accomplished by placing permanent pintle bearings on a number of columns, and by designing the jib cranes so that they can be handled from point to point. The travelling wall crane affords the most satisfactory method of increasing the crane service without interfering with the bridge travellers above, and the column jib cranes below its level.

The electric motor offers the most satisfactory method of operating hoisting machinery. This arises from the convenience with which electricity can be

* Paper presented at the New York meeting of the American Society of Mechanical Engineers.

delivered to these machines by means of sliding contacts. A further advantage lies in the close control of the movement which is essential to the gentle handling and accurate placing on the moulding floor; another distinct advantage of the electric hoist is its ability to hold the load stationary for an indefinite time.

High hoisting speeds are undesirable; in fact the tendency is to get the hoisting speeds too fast in most shop cranes, high speeds being of service only in the handling of bulk materials and package freight. In the foundry a speed of ten feet per minute with full load is ample for heavy work, and speeds exceeding twenty feet per minute are sufficient for the lighter hoists. Positive and uniform motion is necessary in handling copes, and the sudden start of the ordinary air hoists spoils a great many moulds. This sudden start occasionally occurs with electrically-operated hoists having an improperly designed controller.

One of the important advantages of the electrical distribution of energy lies in the fact that only the exact amount of energy is transmitted, and there are no stand-by leakage losses to cause expense. The occasional grounds which appear on the circuits can be taken care of readily, and if the best modern methods of wiring are used very little trouble is likely to occur from this cause. A good quality of insulated wire, run in some form of metal conduit, should be used; wooden moulding should be avoided. The marine type of receptacles are most satisfactory for foundry service, as the water-tight cover supplied with them is equally efficient in keeping out dust and dirt. These receptacles should be installed liberally, as it is a great convenience to be able to get power just where it is wanted.

Another point of no small value is the kind of flexible connections supplied. These are often simply of lamp cord and are more or less of a nuisance, particularly when they get on the floor, where they are liable to be cut by a shovel, etc. Flexible metal tubing makes a first-class protection for such connections, particularly for those which have to carry several horse-power. Connections of this size will be required where portable tools are used.

There are a number of good makes of electric motors on the market, and some that are not so good. A first-class standard motor is desirable, and in equipping a plant it is better to have all of the motors of one make, particularly those of the same size. A little attention to this point will greatly reduce the amount of money it is necessary to invest in spare parts. By a standard motor is meant one which has been made on manufacturing lines in large numbers. In addition to these there are a number of concerns building special motors more or less suited to their special requirements. The designers of such motors are handicapped by the fact that they are not able to avail themselves of the experience gained in the manufacture of a large and varied line. The street railway type of motor frame, or one which is split on an angle, having two poles or one pole in each portion of the frame is the most desirable, owing to the facility with which it can be opened up in cramped places for changing armatures or for other repairs. These motors are of the enclosed type, and have been developed to work under conditions which would discourage the ordinary machine. The manufacturers of these motors often style them as "very rugged," which is an insult to the workmanship and designing ability which has developed these desirable types of machines. Another feature of such motors is the method of lubrication, in which the car box journal has been studied and improved. Lubrication is often neglected by careless operatives, and while any machine is better for a little attention, these motors will stand up under poor conditions.

Moulding machines are generally operated by compressed air, but hydraulic power is used with some machines. Compressed air is elastic, and this is a disadvantage for many operations, as any alteration in the load causes a corresponding change in the position of the actuating plunger or piston. Some compressed air hoists have been designed with a governor device that regulates their speed of action, but it is impossible to avoid the troubles due to the elasticity of the air. Another disadvantage of compressed air machines is the large size of the hose connection required, which is more troublesome to care for than the smaller flexible connection to an electric motor. Compressed air, however, is very useful in cleaning out pockets in moulds and for power ramming machines; for the latter it presents the only successful driving power. These machines are not as widely used as they might be, and where it is desirable to avoid the long air hose connection, a portable motor-driven air compressor can be used. The bellows and torch, for blowing out and skin drying the sand, can be avoided, the former by using the air hose with special nozzles, the latter by arranging some sort of a heating device close to the air hose nozzle. An electric heating device might be serviceable for this purpose.

As generally installed, with a central compressing plant, the use of compressed air requires an expensive transmission line

and in addition, it is impossible to avoid leakage in the joints. Compressed air leakage does not show, and the pipe lines for this purpose, as usually constructed, are designed to remain tight only long enough to pass the acceptance test. Leakage is a continual drain on the system, and shows up in the amount of coal consumed. Except in the large sizes, air compressors are steam eaters like steam pumps; for this reason the small electric driven air compressor presents numerous advantages, as it consumes no power when out of use, and, if portable, avoids the long pipe line. The disadvantages of long air lines are well illustrated by the fact that in some of the big excavating contracts it has been found very advantageous to instal a steam-driven electric generating station at a point where fuel was available from a railroad siding, and transmit electric power to the compressor station located on the work, thus avoiding the losses of a long pipe line or fuel haulage.

Hydraulic power is but rarely used in the foundry. It has advantages for some lines of work. Water being non-elastic, comparatively speaking, it supplies a positive pressure, and while the hydraulic machine can be stalled, it is impossible to break it by legitimate methods, when it is properly designed. The pressures carried in hydraulic systems range around 500 to 1,000 lbs. per square inch; where higher pressures are required in certain machines they are obtained by the use of intensifiers. The most serious disadvantage of hydraulic service systems occurs only where swinging joints are required to convey the pressure and waste water to and from moving machines, as cranes, etc. In the machines themselves the glands are like all other glands, troublesome to maintain, and are often pulled up so tightly that they greatly reduce the efficiency. The controlling valves also give a certain amount of trouble. The most of the trouble with hydraulic systems arises from the use of dirty, gritty water. An illustration of the advantages of using a clean fluid occurs in the hydraulic wheel presses, in which the same fluid is used over and over again; these machines cause very little trouble from leaky glands. High pressure hydraulic systems are, however, expensive to instal, and it is extremely probable that the best method of utilising hydraulic power will be to use an electrically-driven pressure pump with its accumulator installed close to the floor upon which hydraulic moulding machines are to be used. This would reduce the required amount of pressure and waste line to a minimum. Necessarily this small hydraulic plant could not be placed in the foundry itself, but a small pump room would be a requisite.

Steam power was at one time the only motive force available, and was either transmitted to those places in the foundry where it was required by means of belts and shafts, or small engines were used, driving the different machines by belts. In some cases small gas or other explosion motors are used in a manner similar to the early steam motors. Owing to the fact that small engines are not economical, and have several other disadvantages which are familiar to all who are posted on foundry operating conditions, they are not considered as desirable as other kinds of motors. The steam hydraulic crane and elevator, both of which operate on the same principle, are two of the most satisfactory machines devised for foundry service, because they are very simple, and for that reason it is practically impossible for the most careless operator to damage them, except by the most studied neglect. One of the bad features of any transmission system which deals with moist elements, such as water, steam, and sometimes compressed air, exists in their liability to damage in cold weather by freezing. This danger has to be very carefully guarded against in temperate and cold climates, during the night and on all occasions when work is interrupted. To guard against this trouble, some form of heat insulation is required.

As to which is the best power to adopt, depends in a large degree upon the local conditions affecting the plant, and by studying such conditions much better results can be attained than are possible by off-hand decisions. A harmonious installation works more smoothly than a miscellaneous assortment, and, in addition, the design should take into account the future growth as a possibility, this matter being often left out, and resulting in endless complications when extensions have to be made. Because the largest part of foundry power requirements are intermittent, it is extremely probable that electrical methods offer the most economical solution of the question, but against this the question of maintenance is often of more importance than the economy of operating expenses due to cheaper power.

The class of labour employed in many foundry operations is not possessed of any amount of mechanical skill or electrical knowledge, and for this reason it is advisable that the motive power portion of the equipment be as nearly "fool-proof" as possible, and of the simplest possible construction, in order that it may not be damaged by misdirected zeal. The use of

electrical power necessitates the employment of one or more men to look after the motors, depending upon the number used, or else a considerable portion of the minor repairs must be made by outside help. Where the foundry is operated in conjunction with a machine shop the matter of maintenance becomes more simple. With steam, compressed air or hydraulic machinery the question of maintenance is not of such a complicated character as with electrical machinery, owing to the fact that it is much easier to get men who have some primary ideas and break them into the small repairs required to keep the machines in operating condition. And with the exception of the most extraordinary breakdowns, such machinery can be restored to working order by the use of the facilities ordinarily available in the vicinity of a foundry. This, however, is not always the case in regard to electrical machinery, though, since the uses of electrical machinery are extending so rapidly, a time will be reached when the question of repairs will be as simple as it is with other types of motors.

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BRITISH FOUNDRYMEN'S ASSOCIATION.

Birmingham Branch.

THERE was a large attendance of the Birmingham Branch of the British Foundrymen's Association on Saturday, December 14, at the Technical School, Birmingham, to hear a lecture by Mr. R. Buchanan, the President of the Branch, on "Cupolas and Cupola Melting."

Mr. R. Mason presided, and mentioned that the President had lately been elected a Fellow of the Society of Arts.

MR. BUCHANAN preceded his lecture by exhibitions of various types of cupolas shown by limelight. In regard to West's cupola, he said he believed the inventor was the only one who used it. The Greiner cupola worked very satisfactorily on the Continent. At the same time, he thought the principle was wrong, because there was partial fusion outside the melting zone. The Herbertz cupola was excellent for disposing of the dust, but the steam power requisite for the purpose would suffice to drive a 25-h.p. engine. The Whiting cupola was very good, though rather cumbersome. It secured a regular distribution of the blast. Some amusement was caused by an exhibition of a Chinese cupola, carried by Chinamen in sections from street to street, for the purpose of mending rice pans. A melting heat was obtained by charcoal blown with a boy's bellows. The "Rapid" cupola employed cast-iron blocks instead of fire-bricks. It had a brief life, and he believed the idea fizzled out.

Proceeding with his lecture, MR. BUCHANAN said the cupola was never invented in the ordinary sense, but was probably the product of many minds over a long period. With regard to linings, it was questionable whether science had said its last word. Fire-bricks appeared to be the most suitable at present, but at Carnegie's Furnaces mica schist was used with very good effect. With regard to construction, the change from the small diameter to the large should not be too sudden, and in regard to working the operator wanted careful watching. He caught his man some time ago twice missing the limestone. The operator was threatened with the sack, and the omission never happened again. The present tendency was in the direction of lower-blast pressure and larger tuyere areas. Some experiments made by Mr. F. J. Cook had shown a very close connection between the increase of blast pressure and the increase of hardness in the product, which, no doubt, resulted from the increase of combined carbon, and the variation of pressure was found to be due to the varying supply of electricity for other uses in the establishment. Scaffolding might generally be attributed to a deficiency in fluxing material, and light coke was also a fruitful cause, or it might be due to faulty lining. Cupolas with receivers facilitated more perfect mixing. He thought it a good plan to keep the better pig-iron over the worse, rather than *vice versâ*. There were not many advantages either one way or the other, as between the drop or the solid bottom. There was obviously scope for enterprise in the application of gas to cupolas. But so far foundry conditions had not allowed of hot-blast being used. He hoped that in future the judging of pig-iron by fracture would give place to analysis, but he did not see why there should not be chemical tests for each cast of iron, and sales made upon the tests. He thought they had a right to ask the blast-furnace people to give them more regular products, and this would be greatly assisted by the use of metal mixers. It was even necessary that coke should be bought on analysis, owing to the great danger of using coke with an improper amount of sulphur. The analysis of limestone was not so im-

portant as that of the ore, because it was known that many dealers in ore had of late years altered the character of their material to a considerable degree. Low phosphorus iron required more fuel to melt it, and there should be a saving of 2 per cent. in coke for every increase of one-tenth of 1 per cent. in phosphorus.

In the discussion which followed, MR. R. MASON (Chairman) pointed out the great importance of having sufficient knowledge to be able to check the operations of the cupola man. The cupola was very like a wild beast, which suddenly overcame its owner. He did not see how without a lighting door they could get the air in to blow up the fire. They had such an arrangement with the cupolas he had to deal with, and they kept the lighting door open until they were almost ready to put on the blast. Undoubtedly, the greatest improvements in modern cupolas were in the increased height, and everyone who used an old, short furnace knew that it required more coke. Most risky experiments were made by introducing cheaper cokes, and the safe course in such a case was to introduce more limestone to keep it clear. In regard to Mr. Cook's experiments with blast pressure on hardness, they must remember very much depended on the kind of iron and the thickness of the casting. His own firm had not had a complaint of hardness in four years. Generally speaking, it was a safe rule when using more coke to introduce more air.

MR. POOLE would have liked more definite statements, because the variety of results achieved were most confusing. His own experience was that the small cupola was much more difficult to deal with than a large one. With his own cupola, 20 in. diameter, tapering up to 2 ft. at the melting zone, he had been able to work 4 cwts. with 1 qr. 14 lbs. of coke. In America, where they claimed to do things on a grand scale, he understood that in a cupola of 27 in. diameter they melted 3¼ cwts. of iron with 3 qrs. 6 lbs. of coke. He had tried both 3-in. and 4-in. tuyeres, but in dealing with larger cupolas they wanted a larger blast pressure and a small tuyere area, and it was very desirable that the blast should go to the centre of the furnace.

MR. F. J. COOK said the experiments referred to clearly showed that with greater blast they reduced the total carbon. With a higher blast pressure they would get a harder iron, but the hardness would depend on the class of iron. At his establishment, they had fifteen cupolas producing the same iron, but the blast pressure had to be different with all of them. The motors produced more blast in the morning than at night when the electricity was maintaining electric light all over the works. He got over the difficulty by having a man to stand by the switchboard and record the voltage.

MR. SADLER hoped the time would come when a foundry manager would not be engaged without passing an examination. They had too many rule-of-thumb men. Most of their troubles came from want of information. He would like to ask whether the lecturer had had any experience in the use of carburundum in the lining of cupolas. He had tried some experiments in the use of that material, but they were not very satisfactory. He believed the Americans were ahead of this country in that respect. Gas practice was bound to come in future.

MR. A. H. HIORNS said that many difficulties connected with the cupola arose from incomplete knowledge as to the combustion in the furnace. It was most essential that the temperature should be sufficiently high for the carbon and oxygen to unite, and then carbonic oxide would be formed, with a very high local temperature. It seemed to him that hot air, if it could be introduced, would be a very great advantage. Certainly, many difficulties arose through the want of regulation of blast pressure, and they must remember that any increase of temperature beyond that required to melt the slag was so much waste. It would be a most excellent thing if an experimental works, with a small up-to-date cupola were established, with a first-class man in charge, to be supported by the manufacturers of the district. Then they could work at their problems. It might cost a few hundred pounds a year, but the cost to each manufacturer would be trifling, and the engineers, so many of whom in that district wanted high-quality castings, would also benefit. The most foolish, wasteful, and expensive thing he knew was to introduce a cheap coke, because the introduction of 2 to 3 per cent. more ash involved the use of a larger amount of flux in the way of lime, so that for every one part of slag they must introduce three parts of limestone. The objection that gas caused the destruction of the lining could surely be got over by the use of a double case and a water jacket. That would increase the life of the furnace.

MR. BUCHANAN, replying, said he thought the best plan was to train their own cupola man, and it was better to

make a blunder or two than to know nothing about the cupolas. It was sometimes well worth while to get a stuck cupola or two, and a foundryman ought to be allowed to make a few blunders. It was really very difficult to lay down rules, and each man ought to experiment with his own cupola until he got the best results. He had not tested with carburundum. He feared that there was no hope of the experimental establishment suggested by Mr. Hiorns. With regard to water jackets, he had heard of a boiler going inside a cupola, but he believed that if a foundryman took charge of such an apparatus his promotion would be rapid and unexpected. (Laughter.)

The proceedings concluded with a vote of thanks to the lecturer.

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SCRIBING LINES ON A CASTING, PATTERN, OR CORE BOX.

By T. Aldcroft Crosby.

An article appeared in the November issue of the Foundry Trade Journal on "How to Draw Lines Inside a Half-round Core Box," the use of which, it was stated,

Fig. 1.

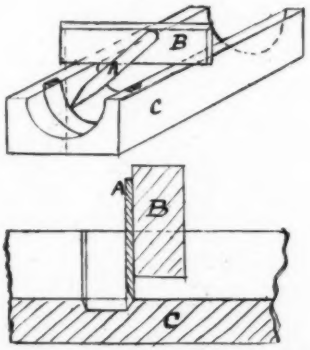


Fig. 2.—Part Section of Core Box through Centre.

A, *Flat Scriber.* B, *Wood Block.* C, *Core Box. Planed at right angles.*

would be appreciated by pattern-makers. It seems to the writer that a young apprentice would naturally use this arrangement, but it is certainly not a true, good, or practical way, as the compasses shown in the drawing would make what pattern-makers term a ragged line. Again, it could be used only in a plain half-round core box, whereas, the method which the author will describe, may be used in innumerable instances, no matter whether on a core box, pattern, or casting, however

Fig. 3.—Section of Circular Cover Pattern.

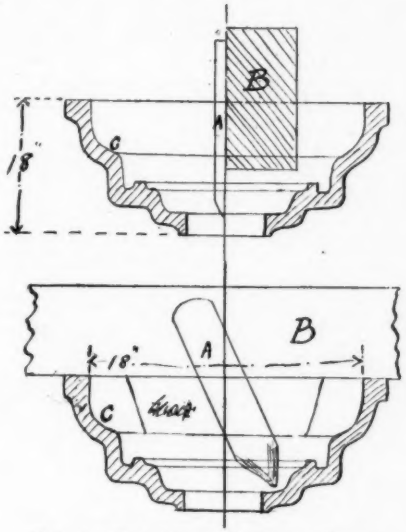


Fig. 4.—Section of Circular Cover Pattern.

A, *Flat Scriber.* B, *Wood Block.* C, *Section of Circular Cover Pattern.*

irregular the section may be, as shown in Figs. 3 and 4.

All that is required is a flat piece of steel 1 in. by ¼ in., with a diamond point

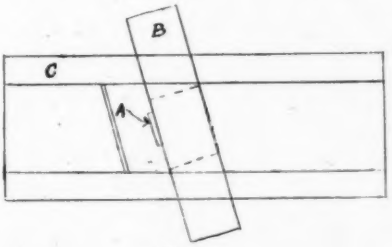


Fig. 5.

ground on it, see Fig. 1. It will be observed that it is not ground to a sharp point, as the scriber works much better if the point is ground about ⅛ in. radius.

The author also finds it very convenient to have two of these scribers, one 6 in. long, and one 12 in. long, for small and large work respectively. It is also a good plan to have various sized blocks (for the same reason) made of dry pine, and kept handy for use; 9 in. by 4 in. by 2 in., 12 in. by 5 in. by 2½ in., 18 in. by 5 in. by 2½ in., 24 in. by 6 in. by 3 in., would be a good assortment for various sized jobs. This method will be found much handier than using a scribing block, as the lines can be put on a pattern, core-box, or casting quite easily in places where it would be very difficult, if not impossible, to get a scriber long enough to reach without springing. Take for instance the pattern shown in Figs. 3 and 4, which is very deep. There are a great number of small pattern shops without a large surface plate. The few illustrations given will explain themselves, but the number of jobs to which this method may be applied is infinite, as the lines may be drawn at any angle (see Fig. 5), by simply moving the block to the required angle on the top of the job. It also has the advantage of being absolutely true, and cuts a very clean line.

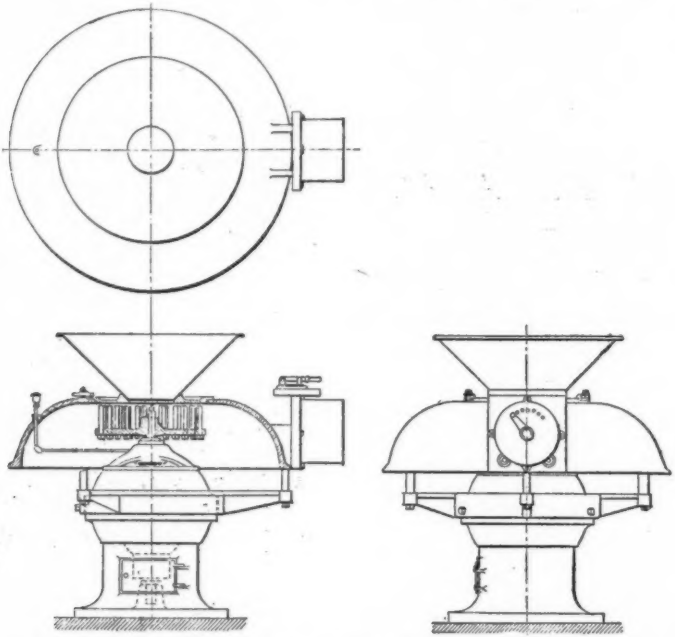
MOULDING SAND.*

The Improvement of Moulding Sand by Mechanical Treatment.

By Alexander E. Outerbridge, Jun.

Next in importance to the various metals of which castings are made, if not indeed of equal importance therewith, must be classed the material of which the moulds and cores are composed. Strange to say, there is comparatively little literature dealing with this important topic in a scientific way and that little is found in technical magazines and in the "Proceedings" of the Engineering Societies. It remains for someone to collate the facts and to present them in a form available to the founder.

The writer will confine his remarks to the practical side of the question and endeavour to show how greatly moulding sand, including core sand, can be improved in its physical properties by correct mechanical treatment; and at the



Section of Centrifugal Sand Mixing Machine with Motor Drive.

* Presented at the New York meeting of the American Society of Mechani al Engineers.

same time how the cost of preparation of the sand for moulds and cores can be greatly reduced as compared with the old-fashioned methods that are still in vogue in many establishments.

In the effort to prevent costly "wasters" in the foundry, which sometimes wipe out the estimated profit on some specific jobs, the composition and physical properties of the different varieties of moulding sand first became the subject of careful study by the writer more than fifteen years ago.

The selection of sand suitable for all purposes in the foundry constituted at that time a not unimportant part of the duty of the very competent foundry foreman.

It was found on looking into the matter that the only tests—if tests they could be called—which were then made of new sand were two in number and exceedingly crude in kind, one being for "toughness," a most important, indeed essential property, the other for "porosity."

The expert's test for toughness consisted simply in squeezing a handful of the sand into the form of a ball and then breaking it, little or no attention being paid, by the way, to the degree of dampness or the more or less heterogeneous composition of the sand. The porosity test consisted, in like manner, in compressing gently a small quantity of the sand between the palms of the hands and then blowing through it. While such tests may seem absolutely absurd in their crudity, it must be admitted that in the hands of an expert they afford a fair degree of practical knowledge of the average quality of the moulding sand.

In order to improve, if possible, on these time-honoured methods of testing sand, the first plan devised was to make a number of test bars of "green" sand, 6 in. by 1 in. by 1 in., under uniform conditions of pressure, dampness, and quantity of material used in forming the moulds. These little test bars were placed upon a smooth metal plate with sharp and square edges. The bars were then pushed over the edge of the plate, until they broke when the amount of the "over-hang" was measured. It was soon found that there was a great difference in the length of the overhang, which was regarded as a quantitative measure of toughness of the sand; these differences were not even noticeable by the crude ball test.

Samples taken from different parts of a small heap of sand that had been uniformly dampened or "tempered," varied greatly in this respect, owing, no doubt, to the irregular distribution of the alumina or clay binder, and the correctness of this inference was subsequently confirmed by simple analytical tests.

After a sufficient number of these test bars had been made and broken to prove the reliability of the method, further tests were devised to ascertain whether the usual methods of riddling and mixing sand for the moulder's use affected its quality, either by increasing or decreasing its toughness, as shown by the amount of overhang of similar test bars of green sand. It was proved that the more thoroughly the sand was worked the greater the overhang, due as already stated to the more uniform distribution of the binder.

The ideal moulding sand is a material in which the individual grains of silex, constituting approximately 90 per cent. of the mass, are completely covered with an overcoat of alumina or clay, and the more uniform the grains are in size and shape the better is the sand with respect to porosity in relation to the average size of the grains.

It was found on passing a sample of sand a number of times through a hand riddle and making test bars from the sample after each riddling that the overhang was increased measurably. Thus, a sample of sand which, after tempering and mixing by hand with a spade, showed an overhang of less than 2 in. of the test bar, increased to nearly 3 in. after a dozen riddlings.

It would not be practicable to treat large masses of sand in this manner, even though a positive and valuable gain in the quality of the sand should be demonstrated by making test moulds from patterns having considerable overhang in places, or in making fine toothed gear wheels, etc., nevertheless the information thus obtained was quite valuable and led to important practical results, as will be seen presently.

Another novel observation was concurrently made, viz., that the increase in toughness and porosity noticed in these tests might be partly due to "aeration," or to the separation of the grains of sand when falling from the sieve to the floor. In order to discover the truth or falsity of this view, a quantity of the sand was shaken in a box with a closed lid for several minutes, and test bars were made before and after shaking; the correctness of this theory was quickly shown, for the shaking without sieving proved to be more effective than the sieving without shaking.

Tests for porosity alone were also made, but as these were not very satisfactory,

owing possibly to want of suitable means of accurately controlling and measuring the amount of air drawn through a mass of sand compressed in a tube, these tests were not prosecuted to a conclusion.

About this time William Sellers & Company began to experiment with a centrifugal machine for mixing sand, and it was found that the desired result could be obtained with such a machine much more expeditiously and economically than by any treatment with riddles or chasers in a rolling mill, and at the same time the toughness and the porosity were increased to a very much greater degree than was possible by the old methods. These satisfactory results led to further experiments in this direction that culminated in the development of a thoroughly practical centrifugal machine, simple in design and substantial in character, which proved so valuable in the foundry that it was placed on the market, and a large number are now in regular use in some of the largest establishments in the country as well as in many smaller foundries.

There are three grades of moulding sand in addition to core sand regularly prepared and used in the Sellers' foundry for the different classes of work. They are classified under the names "Strong Sand," "Special Strong Sand," and "Fine Sand."

The strong sand is used for the majority of the large moulds, such as planer beds and uprights, etc., and for the principal parts of other large machine tools. Most of these moulds are skin dried, or baked on the surface, *in situ*, by means of a portable drying oven after having been "wet-blacked."

The special strong sand is used only for moulds for the heaviest castings, such as large anvil blocks, etc., these moulds are also wet-blacked and when baked on the floor are almost as hard as a stone or as hard as a baked loam mould; this mixture is all new sand.

The fine sand is used for all light castings, and much of the "medium" work; these moulds are not baked and constitute what are commonly called "Green Sand Moulds."

It may be interesting to know the formulæ for the preparation of the three grades of moulding sand given below:—

STRONG SAND.

Strong sand ...	...	(new)=14 parts.
Gravel ...	...	(new)= 7 parts.
Floor sand ...	...	(old) = 6 parts
Coal dust ...	..	= 2 parts.

SPECIAL STRONG SAND.

Strong sand ...	..	(new)= 9 parts.
Gravel ...	...	(new)=14 parts.
Coal dust ...	...	(new)= 2 parts.

FINE SAND.

Weak sand ...	...	(new)=14 parts.
Fine floor sand	...	(old) = 4 parts.
Coal dust ...	...	= 2 parts.

In recent years there has been a remarkable reduction effected in the cost, skill required, and time consumed in making cores by the use of sharp sand and oil in place of the usual core sand mixed with flour or other binders.

The oil sand cores require no ramming, and are made by unskilled labour; cases almost without number might be cited where the actual cost of cores has been reduced by the oil sand method from 50 to 75 per cent. and over, and better results obtained in the foundry, with fewer wasters caused by the breaking down or "blowing" of cores; no venting and but few core rods are needed. Thorough mixing of the linseed oil with the sharp sand is absolutely necessary, though rather difficult to obtain, and in accomplishing this the centrifugal machine is pre-eminent; in fact, it would be impossible without this machine to produce the remarkable results that are now daily recorded with oil sand cores in the foundry.

The centrifugal machine is, of course, equally well adapted to the thorough mixing of core sand with the various core oils and core compounds that are sold for making cores.

Experience has shown that in mixing sharp sand with oil for cores, the centrifugal machine should be run at a lower rate of speed than when mixing, and at the same time tempering ordinary moulding sand. Two treatments are sufficient to insure thorough mixing of sharp sand and oil for oil cores.

In conclusion, it will suffice to give a very brief description of the Sellers' centrifugal sand mixing machine. The machine consists of a rapidly revolving table, having on its upper surface a number of prongs arranged concentrically. The sand is fed into the hopper at the top of the machine, from which it falls upon the revolving table and is thrown by centrifugal force from prong to prong and out against the inside of the cover or hood. It emerges from beneath the hood in a fine shower, free from lumps and thoroughly mixed.

The table, spindle, spindle pulley, and bearings are enclosed in the housing or base upon which the machine stands, so as to protect effectually these parts from sand and dust.

A removable door is placed at the front of the housing to afford access to the spindle and bearings for cleaning or lubrication. The hopper can be lifted off

for convenience of cleaning the prongs or removing stones, nails, etc., which do not pass between them.

The high rate of speed at which the table revolves, from 800 to 1,200 revolutions per minute, causes the sand to be tossed with much force from prong to prong, thus breaking up agglomerated lumps of gravel or clay, insuring not only complete disintegration but a degree of mixing not attainable by any other method. Every portion of sand is thoroughly "combed out," and analytical tests have shown the uniformity of mixture of heterogeneous compounds after passing twice through this little machine.

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A FOUNDRY ORDER SYSTEM.

By L. Tibbenham.

In this brief article it is not the writer's intention to go fully into the method of ordering and storage of castings, but only to describe that small section of the works' organisation which relates to the moulder's order tickets.

Some moulding shops have no method whatever, the chief object of the foreman being "tonnage," no costs being kept, and no check on the true outputs. The men, perhaps, keeping their own account of work done, by chalk marks jotted down anywhere, and often, when some easy job comes along with plenty of weight about it, two or three dozen articles are run off in excess of the quantity required, which, of course, is detrimental to the storage department, and, in fact, to every department in the factory. This necessitates a rule being enforced most emphatically, that no castings will be paid for other than those on the order card; this has quite a magical effect in keeping down the making of unnecessary castings.

Generally the foreman pattern-maker and moulder receive their orders, either from the drawing office or the works order office, and perhaps up to this point the organisation of the management has been everything that can be desired. From this point, however, things are often left to themselves and to the individualism of whoever is charge-hand.

Results Obtainable.

By adopting the system herein outlined, which has been gradually evolved to meet the requirements of a large manufacturing works, each man will know his duties and responsibilities, and the cost department will be enabled to find the amount of productive labour assessed against each class of work, which is seldom obtainable where no methods, with consequent disregard for time and material, are in vogue.

To produce these results, it is desirable to have some kind of foundry-ticket or job-card, such as Fig. 1, which are made up into book form, holding 4 to 1 page

FOUNDRY TICKET	
	DATE
CHECK No.	MOULDER'S NAME.
ORDER No.	
PATTERN No.	DRAWING No.
TOTAL WANTED	No. PER DAY WANTED.
MATERIAL	
PRICE EACH.	
COMPLETED	SIGNATURE.

Fig. 1.

the duplicate copies being perforated to enable their easy removal, carbon paper being used for duplicating.

Duties of Foundry Clerk.

The necessary particulars are filled in by the foundry-clerk; they are then given to the moulder, thus saving the shop-hand doing any unnecessary book-keeping. After the order is completed and the work examined, the foreman signs the ticket, it being finally delivered to the time-office.

No doubt some of the items enumerated on the ticket will be found to be unnecessary in some moulding shops, but

FOUNDRY ORDER TICKET	FOUNDRY PIECE WORK
ORDER No.	CHECK No.
PATTERN No.	MOULDER'S NAME
DRAWING No.	
	PRICE EACH
TOTAL WANTED	
No. PER DAY WANTED	
MATERIAL	DATE
SIGNED FOREMAN'S DATE	COMPLETED FOREMAN SIGNATURE

Fig. 2.

it will only require a small amount of scheming to adapt this principle to any existing shop, however old-fashioned its methods might be, without causing unpleasantness with the employées.

In most large shops there are often several sections or departments in the foundry, casting various metals. When this is the case, as a matter of convenience,

it is as well to have the tickets of various colours, such as grey for soft iron, yellow for brass, blue for steel, etc.

Another Method.

There is a variation of the above method, and one that would be adopted in well-organised establishments, especially where the storekeeper orders all material, as well as receiving and despatching same from his stores, thus enabling the system of maximum and minimum stocks to be introduced, which would be impracticable without some order system. This involves rather more clerical work, which, by the way, should always be placed in experienced hands, and to the uninitiated might appear to have a tendency towards red tapeism.

The method of procedure would then be as follows:—The particulars on the ticket are practically the same, but arranged differently (see Fig. 2), and are made up in triplicate book form (two thin papers, and one thick). The original copy remains in the book, and the other two copies forwarded to the foundry, one of which is filed in the office, and the other given to the moulder. By this arrangement the storekeeper is able to check over the castings as he receives them into his stores.

Card Index.

Also, these tickets, if folded in halves, will be found to be in a handy shape for forming a card index for the foreman's use, three boxes being provided and labelled, orders received, orders given out, orders completed, the tickets being kept in their respective places, thus enabling the foreman to see at a glance the progress of the work he has in hand.

Order Numbers.

The issuing of order numbers presents no difficulties, although it is hardly possible to describe a hard and fast rule for issuing same, but suffice it to say, that they are preferably arranged to run consecutively. It is advisable, when replacing defective castings, to have a distinguishing symbol of some kind in addition to the order number; this enables an accurate record to be kept of the wasters.

When a batch of small castings of the repetition types are ordered, which necessitates the moulder having to retain his order ticket for some considerable time before completion, the quantities must be counted over and signed for on the ticket at least every day, and if uncompleted on pay-day, a new ticket given out in exchange for the old one.

Whenever possible it is most advantageous to keep always the same men, either on day-work or piece-work, but sometimes piece-work men are unavoidably forced to put in a certain amount of day-work. This again, is entered up on the back of the ticket, which is ruled off as Fig. 3. When this is so, and the moulder happens to have several tickets, one, of course, must be set aside for that purpose.

As previously stated, to work a moulding shop of any size economically, methodical principles must be installed, and it pays to adopt clerical labour, to allow the foreman to give the whole of his energies

DAY WORK

	ORDER Nº.	HOURS	SIG.
F.			
S.			
M.			
T.			
W.			
T.			

FIG. 3.

to the production of good sound castings, and also creates a good effect upon the employées by introducing methodical and orderly management.

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MESSRS. M. PAL & COMPANY, engineers, of Parliament Mansions, Victoria Street, London, S.W., have been appointed sole agents for the United Kingdom and Colonies for Messrs. Louis Schwarz & Company Aktiengesellschaft, Dortmund.

THE National Foundry Company, of Erie, U.S.A., is now pouring from 200 to 270 moulds per heat in its steel foundry. It recently broke the record by pouring 275 moulds from an 18-ton heat. Although some of them weigh but 2 lbs. apiece, the castings would average about 60 lbs. each, there being 580 pieces in the heat. This demonstrates that with proper furnace conditions and shop practice it is possible to make a large number of small pieces per heat. It took 1 hr. 35 min. to pour this heat. It is the usual practice for steel foundries to pour from 100 to 200 moulds per heat.

CORRESPONDENCE AND QUERIES.

Edited by C. E. ALLEN.

(Replies to queries in this column will be gladly received).

CASTING GUN METAL PLATES.—Mr. J. Clements writes:—Your correspondent "Randolph" can do much better if he will proceed as follows: Instead of casting those 5 ft. 6 in. plates flat, he should cast them edgeways up, and he could get two or three similar plates in the same mould probably this way. Of course, the pattern will not draw from the sand so easily unless some taper be allowed, though it need only be slight; it can be run from the end and risen through the other end, from top sides of casting, not bottom, or as an alternative, and a good one too, it could be cast from both ends. With this way of casting there should be no necessity to dry the mould at all if made up fairly dry, and with such a good gun metal mixture you should have little trouble in the future. Top sides of such castings are difficult to get, owing to any slight impurities, such as oxides, etc. If cast in horizontal position this method does away with the large flat area of top side of casting that is so often a source of trouble; it will also lessen the liability of your castings scabbing or marking.

CASTING GUN METAL PLATES.—"Randolph's" trouble is no doubt caused by overheating of the metal. Discontinue the 1 lb. of zinc, as zinc fuses at a low red heat, and volatilises at a white heat, and distils over in close vessels; in the open air, at a bright red, it takes fire, and burns away rapidly, and is converted into a white flocculent oxide. The 90 per cent. copper and 10 per cent. tin, is a good standard gun-metal mixture. Use this, and for a flux use ½ oz. of dry phosphorus, place this in the crucible after it has been skimmed off, and stir rapidly. The phosphorus causes the metal to become much more liquid, and when cold to obtain a greater density, as indicated by its specific gravity, than it would otherwise have obtained. Mould your plates as usual, having first drilled a suitable hole in the side of your flask for the runner, and when dry, close your flask, cotter it together, then roll it up on to its edge. Your mould will then be in the best position for casting the plates, and allow an eighth of an inch extra on the upper edge for machining. For facing sand a very good plan is to dry some new sand and pass through a fine sieve, and to each gallon of fine dry sand add from one and a-half pint to a quart of bean flour, thoroughly incorporating together. An hour or so before it is needed, damp a sufficient quantity and rub down until tough, and face with this to a depth of about a ¼ in., no blackening or wash of any kind being needed, as this usually produces a clean polished face on the metal without stemming.—C. E. ALLEN.

MELTING FINE TURNINGS.—In reply to "Reader from the Beginning," as considerable accumulations of turnings, etc., take place in foundries, it becomes necessary to render them available. This is usually done by washing, sifting, etc., before fusing in a crucible with sal-enixum or sulphate of potash, but very much of this labour may be avoided and better results obtained by at once fusing the mixture with soda ash, either alone or in combination with slacked lime, a few ounces of which is sufficient for a pot of 30 or 40 lbs. of metal. Take a crucible unfit for further service with new metal, charge it full of turnings along with the soda ash as stated, melt it after the heats for the day are over, or set aside a furnace for the purpose, and don't fill up the crucible after the first charge is melted, it being bad practice to do so.—C. E. ALLEN.

MIXTURE FOR MOTOR CYLINDERS.—In reply to "W. B. S. G.," it would be a difficult matter to say what is the best mixture for the above, as no two makers favour the same. Try the following, and if it does not give satisfaction, write again, giving fuller particulars as to weight, thickness, etc.:—Select a good brand No. 2 pig-iron, of which take 280 lbs., No. 1 Gartsherrie 140 lbs., No. 4 Madeley Wood 140 lbs., the whole of which make up a 5 cwt. charge, melt in the cupola, and run into bars for the purpose of blending; make the bars 3 ft. long, 2 in. broad, and 1 in. thick, break these up into suitable lengths for remelting in one or more crucibles capable of holding sufficient for one cylinder, it being essential that such articles should be cast from a crucible. You will find this mix very close and strong, and at the same time machines well.—C. E. ALLEN.

SHEFFIELD BRANCH OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

THE second of the series of monthly lectures arranged in connection with the Sheffield and District Branch of the British Foundrymen's Association was given on Tuesday, December 10, in the Lower Temperance Hall, Sheffield. The lecturer was Professor Thos. Turner, M.Sc., A.R.S.M., of Birmingham University, and his subject "The Crystallisation of Cast Iron." There was a good attendance, and the President, Mr. H. Pilkington, M.I.C.E., of Sheepbridge, occupied the chair.

The subject was highly technical, judged from the standpoint of the average moulder, but aided by some excellent limelight photo-micrographs, the Professor succeeded in making very clear the cause of one of the greatest difficulties founders have to contend with in certain classes of castings. What moulder has not at some time been perplexed by seeing castings break when cooling, even though their shape has been such as was supposed to be equal to bearing the strain of contraction, and preventive measures supposed to have been adopted. Explaining the reason for this was the outstanding feature of the lecture, and from what might on the surface appear to be a barren and purposeless lecture, Professor Turner managed to forcibly illustrate the remarkable effect the shaping of crystals during the solidification of the metal has on the subsequent strength of the casting. Crystals arranged themselves according to the shape of the casting, he said, and effectively showed how square edges and angles on a casting were an inevitable source of weakness in consequence of the way in which they cause the crystals to build up in the process of solidification. While crystals were interesting to the mineralogists, said Professor Turner, they were usually to be avoided by the practical metallurgist, on account of the brittleness which they produced. Classifying crystals, he divided them into six systems. The determination of the crystal system, he said, required careful measurements and calculations, because of the different directions of symmetry, the development and suppression of planes, the incompleteness of crystals, and the intersection of crystals.

By lantern illustrations Professor Turner showed crystals in iron, remarking that he did not want to disappoint any of his audience, but to grow a large crystal would take a long time, at least weeks, and would cost a great many pounds in fuel; and he was not sure that it was of any great value when they had got it. (Laughter.) He exhibited a slide of an iron crystal which very much represented a fir tree, and the photograph of another which had quite the appearance of a Christmas tree. As an instance which design has over a casting in regard to its strength, the lecturer exhibited a diagram of a square-bottomed cylinder which was fixed at some works at Wishaw, and immediately the working pressure was applied it was blown in two, the cleavage being from the angles on the square side of the cylinder. Some interesting sketches were also given of cast guns which burst during the siege of Sevastapol to demonstrate that the square band running round the barrel, which was supposed to strengthen the gun as well as ornament it, was really a source of weakness, by reason of the special nature of crystallisation it brought about in the casting. The same applied to all the angles where the shape of the barrel was altered. "You must not have sharp edges, or an abrupt change of shape if you wish to have strength in your castings," was the maxim he laid down. Similarly the Professor illustrated what happens in the crystallisation of mixtures of metals, one notable instance showing how, in a two-ton steel ingot, the upper and central portion showed an increase of 25 per cent. of sulphur and phosphorus as compared with the crust parts tested by analysis. Hence also varying quality and strength in various parts of castings. The whole trend of the lecture was to demonstrate the essential need for a knowledge of this branch of metallurgy if a man desires to be successful in directing founding operations. In cast iron more particularly they had to deal with a complex "mixture," he said, and it was only by a scientific knowledge of the materials, backed by careful tests, that founders could get the proper material and make the castings their customers required.

On the motion of the CHAIRMAN, seconded by MR. PERCY LONGMUIR, who remarked that the design of castings was one of the greatest difficulties foundrymen had to contend with, Professor Turner was thanked for his services.

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A DISSOLUTION of partnership is notified in connection with Messrs. L. J. Abrahams, E. H. F. Heneage, and E. S. Marks, mining and mechanical engineers, Ely Place, E.C.

THE BRASS CASTING REGULATIONS.

Inquiry at Birmingham.

On December 16 an inquiry was opened at the Council House, Birmingham, by Mr. William Wills, a Home Office Commissioner, into objections which have been made to the draft regulations (published in the Journal of July last), proposed by the Home Department relating to the precautions necessary to maintain the health of workpeople in brass foundries.

The inquiry was attended by about seventy employers in the capacity of objectors. Amongst the legal and other representatives were Mr. J. J. Parfitt, who was counsel for the Birmingham Brass Masters' Association and the Birmingham Chamber of Commerce; Mr. Thornton Laws, counsel for the Home Office; and Mr. W. J. Davis, the General Secretary of the National Society of Brassworkers and Metal Mechanics. Mr. Davis intimated that he was there in the peculiar position of being an objector, but he had certain proposals to make on behalf of his Association, and he would call witnesses in support of them.

Opening the case in defence of the draft regulations, Mr. Laws said there was medical evidence which went to show that persons engaged in the casting of brass were subject to a form of ague. Their health was further affected in many other ways, and it was also the case that brassworkers lived a shorter time than men in many other employments. The complaint he referred to as ague was not a new discovery, as it was called attention to as long ago as 1862. In 1896 a Departmental Committee was appointed to inquire into the health of the brassworkers, and they reported that one of the reasons which made the work so unhealthy was the large amount of "smother" which arose when the crucible was lifted from the furnace. Brassfounders' ague could not be reported on as most diseases could, because its attacks were liable to occur at any moment and did not last very long. At the same time the effect on the system was very deleterious. Few brassworkers lived to a greater age than sixty, and some doctors put the maximum age at fifty-five, or even fifty. The draft regulations were framed with a view to improving on the special rules made in 1896, and by so doing it was hoped to eliminate, as far as possible, the diseases which had proved so injurious, especially to Birmingham workers. The history of the last five years amongst the industries of this country went to prove an immense benefit to the health of the workers whenever exhaust ventilation had been employed. This form of ventilation would render the fumes innocuous at the outset, for their danger lay in the possibility of inhaling them.

Dr. Thomas Morrison Legge, H.M. Medical Inspector of Factories at the Home Office, who was the first witness, said he made investigations some time ago in Birmingham, and found that 53 per cent. of the brasscasters were familiar with the symptoms of the malady peculiar to the trade. The complaint was not to be found in industries where there was no pouring of metal. Brassworkers' ague permanently affected the lungs and other organs.

Major C. T. Salmon, of the Royal Army Medical Corps, said he was at Woolwich Arsenal in 1901, and found many cases of brassworkers' ague. It was in a badly ventilated shop that the cases occurred, and the men were surrounded by an atmosphere of fumes. Cross-examined by Mr. Parfitt, the witness said it was possibly true that natural ventilation would cope with the evil, given suitable conditions. In 1901, when he found the cases of ague at Woolwich, the South African war was in progress, and the men were working night and day.

Mr. Parfitt remarked that exhaust plant had been tried by the Government, but it was found impracticable, because the draught cooled the metal in the process of pouring, and thus had an injurious effect upon castings.

Evidence was then given by several workmen to the effect that the installation of ventilating fans in casting shops had greatly improved their health.

Mr. J. T. Geeson said there was a fan in the shop he worked in, and during the last four years he had gained three stones in weight. Replying to Mr. Parfitt, the witness said his work was sand-casting. It was not so important to keep the air still in that as it was in strip-casting.

Mr. G. Waldron, another caster, said a fan had improved his breathing by clearing the air of sulphur, whilst Mr. W. Bell bore testimony to the fact that the provision of a fan had cured him of the "metal ague."

Mr. William Lynes, who has invented an apparatus for removing the fumes from the casting shed, said the starting point

should be to prevent the fumes getting into the atmosphere. He claimed that his appliance would take away 80 per cent. to 90 per cent. of the fumes.

Replying to a question by the Commissioner, MR. PARFITT said he should not adopt the attitude that the maladies referred to did not exist. He should suggest that something ought to be done; the only question was what form that something should take. His main point on behalf of the masters was that the draft regulations needed considerable modification, and the only question was that one wanted to make it as little stringent and severe as possible upon both masters and men. It was the desire of both masters and men that the position which had arisen should be dealt with.

MR. W. ROGERS, a Birmingham brasscaster, spoke of the danger to employés caused by fumes arising from molten metal. He had used two of the extractors spoken of by Mr. Lynes, and found they were of much benefit to the men, as they cleared the shop of about 90 per cent. of the fumes.

DR. ROBERT M. SIMON testified to an extensive evperience of brassworkers' maladies. In an ideal casting shop there would be either no, or very little, disease. If a shop were ideally ventilated the fumes would be carried away. Brasscasters suffered chiefly from a kind of intoxication or poisoning very much like nicotine poisoning. There was nausea and sometimes vomiting, cold sweats, and stomachic discomfort, and collapse. This was, of course, in proportion to the condition of the workman before he came to work, and what amount of fumes he consumed. The greater mischief, however, was a tendency to bronchitis; and the defective condition of health due to bronchitis might lead to phthisis.

DR. J. G. EMANUEL, of the Queen's Hospital, Birmingham, said they got large numbers of brasscasters at the hospital. He had been struck with the number of men who suffered from the so-called brasscasters' ague and chronic bronchitis. The men were originally of good physique, but they appeared to be suffering from a chronic kind of poisoning.

This closed the case for the Home Office.

Mr. Parfitt then called MR. R. G. EVERED, whose works are at Smethwick. He said a great deal of the difficulty arose from small shops. There were certain shops at present existing in Birmingham which should be closed if the inspector had power to close them. He had considered the form of the draft regulations, and as the result of a conversation with Mr. W. J. Davis, had arrived at modifications which, in his opinion, would be reasonable and workable as between employer and employed. He was of the opinion that mufflers were efficacious in keeping off the fumes when they were used; but the use was optional, and though some casters did use them it was difficult to get the practice carried out regularly. If, in addition to the use of mufflers, there was sufficient ventilation, the risk of danger would be very considerably reduced. If they were empowered to use fans or other means of ventilation without jeopardising the casting itself—in the case of strip casting—he thought there would probably be no difficulty. He regarded Mr. Lynes' apparatus as too cumbersome and inefficient for strip casting. He did not know of any contrivance at present which dispersed the fumes other than by exhaustion.

MR. G. HOWARD said he had been used to sand casting for fifty-three years. Whenever he was engaged in pouring he used a muffler, and it always protected him against the fumes. He had had "metal ague" about seven times during the past fifty years. He thought Mr. Lynes' apparatus was all right for strip casting, but it was no good for sand casting.

MR. J. H. BARKER, General Manager of the Birmingham Metal and Munitions Company, said in the manufacture of ammunition they had to produce brass strip, which had to be as sound as it was physically possible to make it. He did not favour Mr. Lynes' plant. It was possible to produce ventilation which left the air undetrimental to the workmen, and, at the same time, did not interfere with the manufacture of the strip. They relied on lofty workshops, with a minimum cubic capacity of 2,000 ft. for each man.

MESSRS. JOHN S. HARRISON, Factory Superintendent for the Munitions Company; J. W. MADELEY; and G. H. DUGARD gave similar evidence.

MR. J. J. PARFITT, representing the Birmingham Brass Masters' Association and the Birmingham Chamber of Commerce, called further evidence on behalf of the manufacturers.

MR. H. JONES, a foreman caster, who had been in the employ of Messrs. Earle, Bourne & Company for fourteen years, said his health had not been affected in any way. In regard to workshop conditions, he said there should be no current of air attacking the surface of the metal as it was poured into the mould. He did not think Lynes' apparatus for removing

fumes from the casting shed was at all suitable for the tube or strip casting trade. The men suffered a little on Monday, but they were all right by Tuesday. He had suffered from shivering, but had never been sick. Most of the casters had been off ill at times, but when they returned to work they put the illness down to beer. He had never found any yet who drank milk. (Laughter.)

Mr. Alfred Giles, partner in the firm of Messrs. F. Giles & Son, who make castings for their own purposes, said the contention of his firm was that if the shops were properly built the percentage of illness was exceedingly small. His firm had seven casting shops, and there had been practically no cases of illness amongst their casters for many years past. The new part of their premises was built with great care, and they had only one tub in each casting shop. Two men worked in each shop, and pouring took place about every hour and a half. The door was kept open during the pouring, and the fumes got away in two or three minutes, or, if the weather was heavy, in four or five minutes. The illness among casters was simple compared to that among dressers. He did not believe there were many foundries in Birmingham where there was only one tub in a casting shop. His casting shops were 12 ft. long by 8 ft. wide, and the height sloped from 12 ft. in front to 17 ft. at the back. Fans had been adopted in the polishing shops with good results, because there thirty or forty people were at work. His opinion was that a small casting shop with two people at work and only one tub was a better system than any other. One great trouble would be relieved if the Home Office had power to condemn unsuitable shops.

Mr. S. Sanders, of Messrs. Charles Clifford & Sons, and the Delta Metal Company, who do strip and tube casting, agreed that absolute stillness of the atmosphere was necessary when the metal was being poured into the mould. Ventilation by means of fans at a suitable distance from the metal could be used, and, in his experience, it was beneficial, but great care had to be exercised in regard to the position of the fan. Two thousand cubic feet of air space in shops per caster would be ample. Cases of serious illness were rare among the men employed by the firms with which he was associated.

Mr. J. Faulkner, 74 years of age, said he had worked as a caster for Messrs. Charles Clifford & Sons for 45 years. During that time he had never been ill as the effect of his work, and had suffered only from bronchitis for five weeks, seventeen or eighteen years ago. Cross-examined, he said he had never had a shivering, but his mates had, and a good many had knocked off work. Some of them had forgotten to come back.

This closed the case for the manufacturers.

Mr. W. J. Davis, who represented the National Society of Brassworkers, said there was a consensus of opinion that there was illness in the trade, and therefore he desired to shorten the evidence he had to submit.

Mr. Samuel Millward, Secretary of the National Brassworkers' Association, Rotherham, said that at a meeting of brasscasters on December 11, at Rotherham, a resolution was passed strongly protesting against the statement that they would not use soap, towels, and nail brushes. The witness added that some apparatus was required in the shops to reduce the fumes.

Evidence was also given by Mr. A. Perry, of Smethwick, who spoke of the effects of the fumes; and by Mr. James Scott, of Wolverhampton, who put in a resolution similar to that passed at Rotherham. The Wolverhampton brasscasters were of opinion that the Home Office regulations should be put in force.

Mr. John Jones, a sandcaster, of Birmingham, said he had had two years' experience of the Lynes' apparatus, and would not work without it unless he was compelled.

Mr. W. Baker said the Lynes' patent was used where he worked, and there were no more fumes than would be caused by smoking a pipe.

Mr. John Ramsden, Vice-President of the National Society of Amalgamated Brassworkers and Metal Mechanics, who has been a brasscaster for 47 years, said it was necessary in the interests of the caster's health that he should be cleanly. It would be a great advantage if the supply of hot water, soap, towels, and nail brushes were made compulsory on the employers, and he would summon the men who did not use them.

Mr. R. A. Chattock, electrical engineer for the City of Birmingham, said the probable cost of hiring an electric motor and fan would be £3 per annum. The cost of running an 18-in. fan for one and a-half hours a day at the present price of current would be £1 10s. per year, and the structural alterations necessary for installing such a fan and motor would cost £10 or £15.

Mr. Lawes, representing the Home

Office, at this point said that Mr. Parfitt, Mr. Smith, Mr. Davies, and himself met the previous night and discussed certain amendments to the draft regulations. The discussion was entirely informal, and they drew up a document which the Commissioner ought to see before it was made public. It gave the heads of the agreement they were able to come to. Mr. Smith had asked him to go to Glasgow, and the Home Office were only too pleased to fall in with the suggestion that they should see how differently the trade was there carried on.

Mr. Smith, on behalf of the Scottish engineering firms, said it was perfectly clear that the whole of the case, as far as Birmingham was concerned, had been dealt with, and that of the rest of the country had been left alone. There was a trade carried on in Birmingham that did not seem to be carried on in any other part of the country, the industry in other places being not the least like that of Birmingham. He therefore asked the Commissioner to hear evidence in Glasgow and in Newcastle and London.

The Commissioner thought the application reasonable, and proposed to adjourn the inquiry and continue it probably at Glasgow.

Mr. Smith observed that the evidence in regard to the other English industries could be submitted in London.

Mr. Parfitt said that as the result of the Conference between the Home Office and the masters and the men, represented by Mr. Davis, the proposals submitted to the Commissioners had been agreed to, and had been handed in for consideration. He suggested that when the Commissioner had the Glasgow evidence there should be an opportunity to discuss in London whether the regulations were on the whole fair as between the masters and the men. The proposals submitted to the Commissioner were not hastily arrived at, but they were tendered only as a sort of contribution to the solution of the difficulty, and it was open to the Commissioner to say either that they were too stringent or not stringent enough.

Mr. Davis said that after the Conference he had the opportunity of attending a meeting of the men in Birmingham, and they were of opinion that the proposals agreed upon offered a fair solution of the difficulty.

The inquiry was adjourned, the Commissioner intimating that the objectors would receive notice of the meeting in Glasgow, and that addresses on the evidence would be heard in London.

BOTTOM-POURED CRUCIBLES.*

In spite of their meagre use, the bottom-poured crucible is a distinct advantage in many lines of work, and gradually manufacturers who melt metals are beginning to find uses for them. The fact that they are self-skimming is directly in their favour.

By a bottom-poured crucible is meant one in which the metal is drawn from the bottom of the crucible, and not from the top, as in the ordinary shapes. The advantage of this feature is readily apparent. All the dross which floats to the top of molten metal is retained and does not enter the mould.

By referring to the illustrations, the manner of making bottom-poured crucibles will be seen. A tube is made on the side of the crucible so that it reaches half-way down the interior. By referring to Fig. 1, a cross section of a crucible of this nature may be seen. The tube does not reach completely to the bottom but only about

Fig. 1.—A Bottom Poured Crucible.

half-way. This has been found the best practice. Near the top a web is made across one side of the crucible. The object of this web is to act as a skimmer and prevent dross and metal on the top of the crucible from entering the mould. This web may be seen in Fig. 1.

The method of using the bottom-poured crucible is the same as that followed with ordinary shapes of crucibles. After the metal has melted, however, a rod is pushed down the tube in order to break up the dross or charcoal that may have lodged there. It is also well to pour out the first portion of the metal into an ingot mould, and then begin pouring the mould. The first portion of the metal is apt to contain a small portion of dross that has lodged in the tube.

The advantage of the bottom-poured crucible lies, as previously mentioned, in its self-skimming feature.

* Brass Mould.

THE SZEKELY PROCESS.

A DEMONSTRATION of the Szekely process for producing sandless castings was recently witnessed by our representative, and will be particularly interesting, as it touches closely on the article on sandless castings, by Mr. J. H. Shaw, published in the FOUNDRY TRADE JOURNAL of November last. The process was the invention of Dr. Szekely, as mentioned in our December issue, and the demonstration took place at the Rodney Foundry, Southwark. The process is almost identical with Mr. Shaw's description, and in the course of an interview Dr. Szekely claimed that the description was of his process which he has already successfully established in America. The inventor stated that he has taken out a practically universal patent for his invention, and is now negotiating for the disposal of the rights in England. Until these negotiations are completed he is not disposed to impart information as to the composition with which the mould is coated or washed, as this is an essential feature of the patent. The intimation that Messrs. Alfred Herbert & Company are using the Szekely process is incorrect, for though that firm are casting direct into metallic moulds, the absence of a chill on the casting, which they attain, is merely the result of using a non-chilling pig-iron. It is claimed for the Szekely process that with any ordinary foundry mixture no chill is experienced, and, moreover, no shrinkage is traceable when the casting is cold.

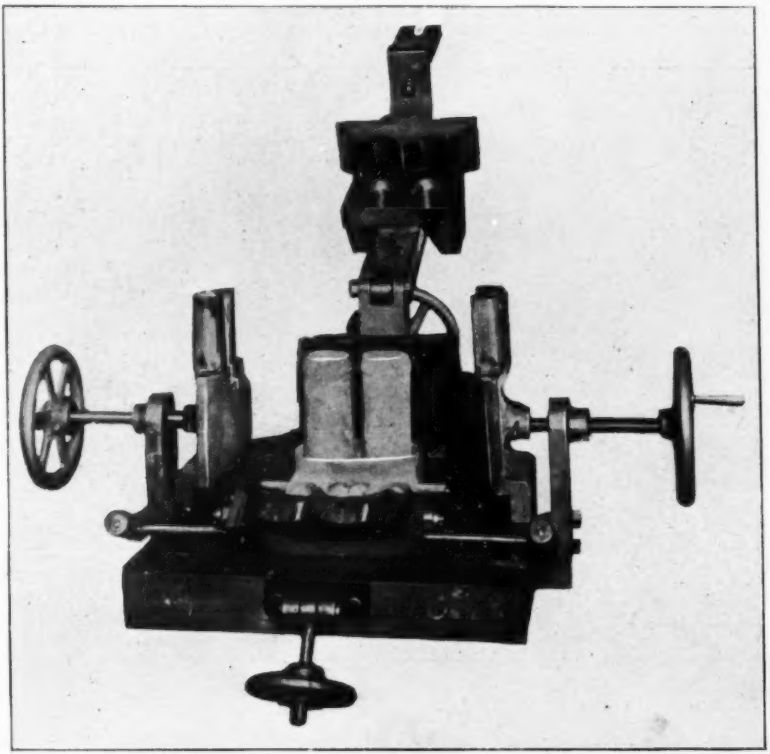

FIG. 1.—MOULD OPEN, WITH CORES IN POSITION.

As already stated, the system is essentially adapted to repetition work, the moulds being of cast iron, and so practically indestructible. These are made in the necessary parts by the usual sand method, and are then mounted in a shell,

which is so constructed that the various parts can be readily released and drawn away from the casting by means of automatic springs and screws. Ordinary sand cores are used for complicated castings, and except for the cores, no venting is necessary. The parts of the mould being in position on their respective adjusting beds, those surfaces coming in contact with the metal are washed with the solution mentioned. The whole is then screwed up tightly, and the metal poured in quickly. Pouring is done from the top, so that the metal having once taken its position in the mould is not disturbed as in the case of bottom pouring. An important point also is that the danger of bursting which is incurred when large sand cores are used in a closed iron mould is obviated. Only a few seconds after pouring is completed the mould is opened and the casting taken out. The resulting casting is a smooth, well-defined, and easily machinable product, and a prominent feature of the work is the absence of any shrinkage. To test the question of shrinkage several cold castings were replaced in the mould, and they were proved to fit exactly. This, in consideration of the allowance made in ordinary sand practice, is a striking feature of the process, and when taken in conjunction with the cleanness of the casting, as compared with sand mould work, presents much that is desirable. Dr. Szekely had previously given several demonstrations of his process, dealing with the casting of a brake shoe. In regard to these, it was admitted by several eminent foundrymen that, so far, everything claimed for the process had been accomplished, but it was considered that a brake shoe, being a comparatively simple piece of work, did not constitute a sufficient test of the process, and, accordingly, a further demonstration was arranged, the casting in this case being a double motor cylinder, since it could not be said that this piece of work was other than an extremely difficult casting to make. The success with which the experiment was attended was highly satisfactory, particularly as the inventor eventually found himself handicapped for time. Within nine days from the commencement of the patterns for the moulds, the complete apparatus was ready for the experiment, and the first casting taken from it was that witnessed at the demonstration. The experiment, however, proved completely successful, the apparatus turning out a well-finished and easily machin-

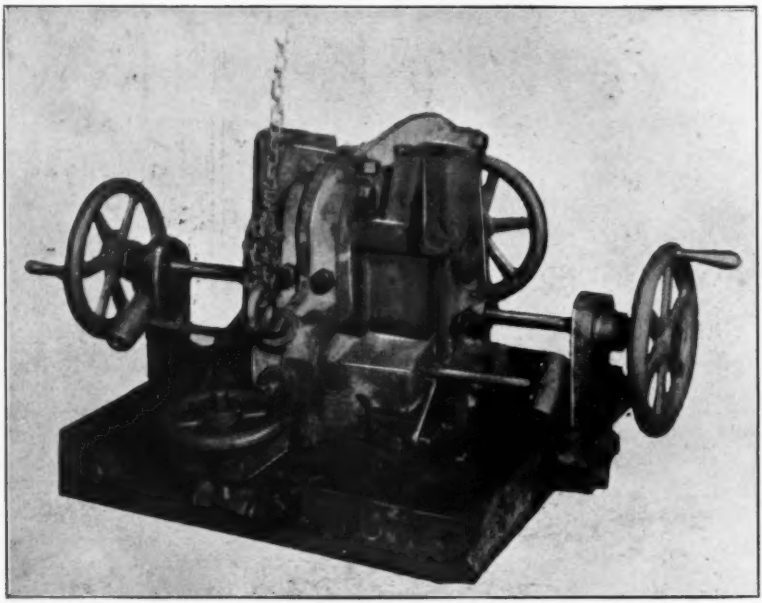

FIG. 2.—CLOSED MOULD.

able casting. Mr. Shaw in his article states that several of the first castings from a cold mould have to be discarded. The inventor proved, however, that, generally speaking, one casting is sufficient to heat the mould to the point of producing satisfactory work, though he admitted that the later ones were perhaps a trifle superior. That the success of the process is not dependent on the mixture was shown by the fact that the metal was that which was being used by the foundry for the day's work. It was afterwards ascertained from the representative of the Rodney Foundry Company that the mixture was composed of a charge of 2 cwts. hematite and 10 cwts. scrap.

At a previous exhibition of the process a brake shoe was cast, and after being allowed to cool for about two or three minutes, was, while still red hot, quenched in cold water. The casting was then broken in the usual way with a sledge hammer and examined, and it was found that, though cast in an iron mould and quenched while red hot, yet the surface was in no way chilled or hardened by the treatment. Moreover, the metal was close in texture; that it was tough was effectually shown by the amount of hammering required to break it. One of the pieces of the brake shoe was afterwards drilled in an ordinary drilling machine, showing that the surface of the casting coming in contact with the mould had not been in any way "chilled," and, further, the metal cut by the drill was of excellent quality, soft, tough, and silky. The mixture was practically the same as previously stated, being taken from the cupolas in work for the ordinary work of the foundry.

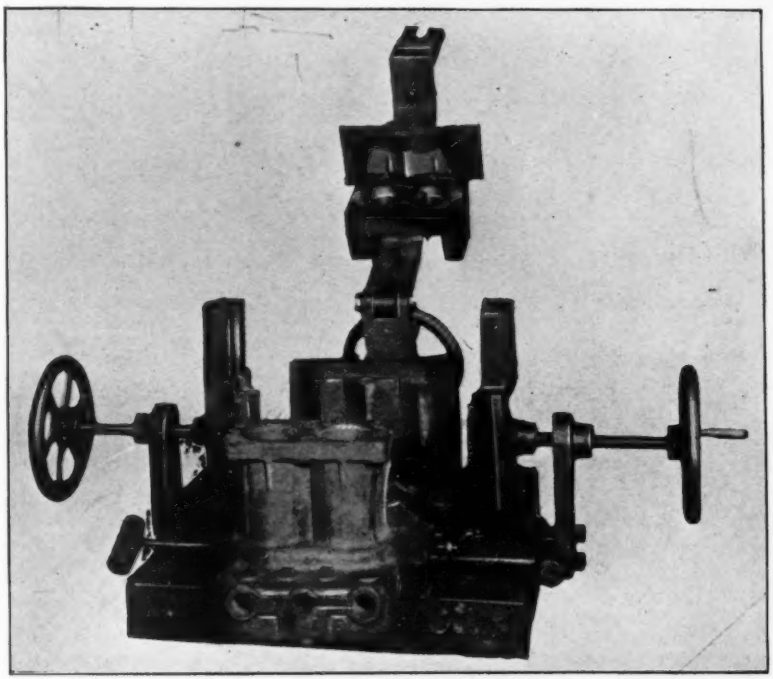

FIG. 3.—FRONT OF CASTING.

A notable feature of the castings produced by this process is the absence of blow holes, even in the gate, which in the case of sand mould work is commonly open-grained, and with numerous blow holes. The superior finish of the casting, as compared with those taken from sand, should allow a considerable saving in time when passed on to the shop for machining.

In the illustrations will be seen the various stages in the process of casting.

In the first illustration will be seen the mould open and the cores placed in position ready for the closing of the apparatus, the solution or wash having been applied. Fig. 2 shows the closed mould ready for pouring, while in Fig. 3 will be seen the casting, which was removed from its bed directly pouring was completed and the mould opened. The fourth illustration gives a view of the casting, which was

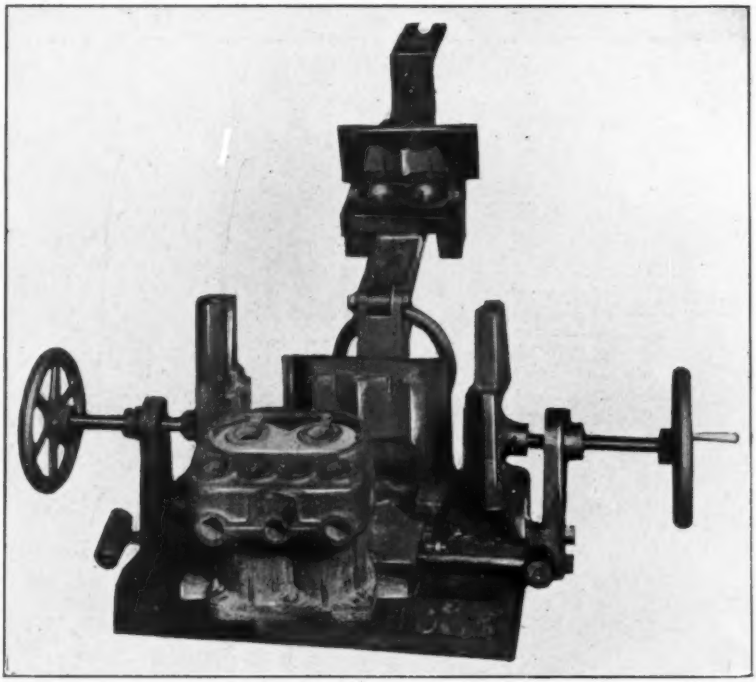

FIG. 4.—BOTTOM OF CASTING.

turned upside-down to show the cleanness of the most intricate part of the work.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR.—In last month's issue of the FOUNDRY TRADE JOURNAL, we notice that you give the description of the "Szekely" process for producing iron castings from metallic moulds. In this article you say "the process is an invention of Dr. Charles Szekely, of 113, Clement's Inn, London, W.C., and in addition *to having been used for some time past at the works of Messrs. Alfred Herbert & Company*, it has been demonstrated before a Commission of the United States Patent Office." We would point out to you that this process is not nor ever has been used by us. The method which we use for producing castings in metallic moulds, which was invented some two years ago, and which has been in use in our foundries ever since, is totally different to the "Szekely" process, as one of the chief points in our method is the use of a non-chilling mixture of iron. Dr. Szekely claims to be able to use any mixture of iron.

You will agree that your article gives one the impression that the process used by us is identical to that of Dr. Szekely's. We shall be much obliged if you will be kind enough to give this disclaimer the same prominence in your next issue as you have given the description of the "Szekely" process in the current issue.

Yours, etc.,
FOR ALFRED HERBERT, LIMITED,
E. H. Broughall.

ANALYSES OF BRITISH PIG-IRON.

The Park Gate Iron & Steel Co., Ltd.,

PARK GATE WORKS, ROTHERHAM.

Brand—"P.G., Lincoln."

	Si.	S.	P.	Mn.
Basic iron	0.55	0.050	2.70	2.25
No. 3	2.20	0.035	1.40	1.60
„ 4	1.50	0.050	1.50	1.50

Walter Scott, Ltd.,

LEEDS STEEL WORKS, LEEDS.

Brand—"L.S.W."

	G.C.	C.C.	Si.	S.	P.	Mn.
Basic iron—						
No. 1 White ...	trace	2.50	0.56	0.068	2.75	1.40
„ 2 „ ...	nil	2.50	0.51	0.096	2.70	1.00
„ 3 „ ...	nil	2.50	0.51	0.130	2.68	0.68
„ 1 Grey ...	2.00	0.50	1.10	0.060	2.75	1.50
„ 2 „ ...	1.00	1.50	0.81	0.065	2.75	1.44

SCOTLAND.

Carron Co.,

CARRON IRON WORKS, CARRON.

Brand—"Carron."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	3.500	.040	2.800	.035	.880	1.450
„ 2	3.370	.250	2.275	.045	.907	1.450
„ 3 Soft	3.280	.180	2.050	.038	.902	1.400
„ 3 Foundry ...	3.350	.200	2.150	.035	.907	1.311
„ 3 Close ...	3.170	.280	1.750	.050	.905	1.420
„ 4	3.160	.290	1.570	.060	.905	1.450

Coltness Iron Co., Ltd.,

NEWMAINS, N.B.

Brand—"Coltness."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	3.45	0.20	3.43	0.022	0.982	1.58

Dalmellington Iron Co., Ltd.,

DALMELLINGTON.

Brand—"Dalmellington."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	2.80	0.63	2.93	0.03	1.25	1.22

James Dunlop & Co., Ltd.,

CLYDE IRON WORKS, TOLCROSS, GLASGOW.

Brand—"Clyde."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1...	3.35	0.30	2.88	0.03	0.89	0.62
„ 3	2.89	0.52	2.87	0.03	0.92	0.54

The Glengarnock Iron & Steel Co., Ltd.,

127, ST. VINCENT STREET, GLASGOW.

Brand—"Glengarnock."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	3.50	0.20	3.50	0.04	0.60	1.30
„ 2	3.25	0.25	3.00	0.04	0.60	1.25
„ 3	3.25	0.30	2.50	0.05	0.60	1.25
„ 3 Hard ...	3.10	0.35	2.00	0.06	0.60	1.20

The Langloan Iron and Chemical Co., Ltd.,

COATBRIDGE.

Brand—"Langloan."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	3.45	0.20	3.25	0.015	0.70	1.00
„ 2	3.10	0.45	2.75	0.030	0.70	1.00

Merry & Cuninghame, Ltd.,

127, ST. VINCENT STREET, GLASGOW.

Brand—"Carnbroe."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	3.75	0.08	3.60	0.035	0.93	1.20
„ 3	3.45	0.30	2.75	0.048	0.93	1.10
„ 4	3.25	0.49	2.10	0.075	0.91	0.92

Summerlee & Mossend Iron & Steel Co., Ltd.,

SUMMERLEE, NEAR COATBRIDGE, N.B.

Brand—"Summerlee."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	3.93	0.25	2.85	trace	0.911	1.08

ANALYSES OF BRITISH PIG-IRON—*continued.*

WALES.

The Blaenavon Co., Ltd.,

BLAENAVON WORKS, BLAENAVON, MONMOUTHSHIRE.

Brand—"Blaenavon."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	3.40	0.20	2.50	0.02	0.045	1.30
,, 2	3.00	0.30	2.10	0.03	0.045	1.15
,, 3	2.81	0.45	1.80	0.05	0.046	1.00
,, 4	2.55	0.55	1.40	0.07	0.046	0.80

The Briton Ferry Works, Ltd.,

BRITON FERRY, GLAMORGANSHIRE.

	G.C.	C.C.	Si.	S.	P.	Mn.
Nos. 1, 2 and 3 Bessemer	—	—	2.5-3.0	0.04	0.04-0.06	1.0-1.5
No. 3 Foundry	—	—	1.0-1.5	0.08	0.04-0.06	0.7-1.0

The Brymbo Steel Co., Ltd.,

BRYMBO STEEL AND INGOT IRON WORKS, NEAR WREXHAM, DENBIGHSHIRE.

This Firm's production is all used by themselves.

The Ebbw Vale Steel, Iron and Coal Co., Ltd.,

EBBW VALE, R.S.O., MON.

Brand—"E. V. S 2."

	G.C.	C.C.	Si.	S.	P.	Mn.
Bessemer—						
No. 1	3.50	0.17	3.50	0.02	0.06	0.59
,, 2	3.37	0.24	3.00	0.05	0.06	0.50
,, 3	3.05	0.35	2.50	0.06	0.06	0.50

LIST OF NEW INVENTIONS.

Specially compiled for THE FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, Consulting Engineer and Chartered Patent Agent, 77, Colmore Row, BIRMINGHAM.

24,968. F. G. BUENDIA. New process for the concentration and preparation of minerals.

25,357. H. ROSALT. Improvements in or relating to the treatment of ores for the extraction of metals therefrom.

25,717. B. ABRAHAMS and T. A. F. W. LAGERWALL. Improvements in or connected with moulds for casting metals.

25,742. COMPAGNIE DES FORGES ET ACIERIES DE LA MARINE ET D'HOMECOURT. Improvements in and relating to steel suitable for the manufacture of armour plates, projectiles and other bodies.

25,985. A. S. DWIGHT and R. L. LLOYD. Improvements in and relating to apparatus for roasting and sintering ores.

26,131. M. MOORE and J. T. HESHETT. Improvements in the process of and apparatus for directly reducing iron ore and subsequently treating same for the manufacture of wrought iron and steel.

26,210. E. WALKER. Improvements in the casting or covering of iron, steel, or other metal tubes, or bars with lead or any of its alloys.

26,790. H. HEMSCHEIDT. Improvements in machines for ramming the sand in pipe casting moulds.

26,810. M. RUTHENBURG. Improvements in or relating to the concentration of ores containing wolfram.

26,877. F. PENLINGTON. Improvements in or in connection with core-making and sand moulding machines.

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DURING the six years that Crossley Brothers, Limited, have made gas producer plants, they have turned out gas plants of the aggregate capacity of about 200,000 h.p., the sizes ranging from 5 h.p. to 4,500 h.p.

TRADE TALK.

MESSRS. C. W. RATCLIFFE and F. RATCLIFFE, engineers, Leeds, have dissolved partnership.

MR. J. SYDENHAM has established himself in business as a consulting engineer at Penarth.

MR. F. A. SMITH, engineer and ironfounder, of Reading, Berkshire, has been adjudged bankrupt.

W. H. A. ROBERTSON & COMPANY, LIMITED, engineers, have established the Lynton Works, Bedford.

THE VICTORIA FOUNDRY, Cardiff, was offered for sale by auction recently, but was withdrawn at £600.

HOSKINS, LIMITED, engineers and ironfounders have acquired the Eskbank Iron Works, New South Wales.

A NEW London branch of Simplex Conduits, Limited, has been opened in Charing Cross Road, W.C.

A RECEIVING order has been made in connection with Messrs. J. Lee & F. W. Millman, engineers, Plymouth.

PROFESSOR TURNER recently lectured to the members of the Birmingham Metallurgical Society of "Puddling."

MR. THOS. TILL, ironfounder, Hanley, has paid a first and final dividend of 20s. in the £, with 4 per cent. interest.

A DISSOLUTION of partnership is notified in connection with Messrs. A. Whitcomb and G. H. Pym, engineers, Bristol.

MESSRS. THORNEYCROFT & COMPANY earned a bonus of £12,000 from the Admiralty by the record success of the destroyer "Tartar."

A RECEIVING order has been made in connection with the affairs of Mr. P. J. Mallmann, consulting engineer, Wool Exchange, London, E.C.

THE directors of the Wellman Seaver-Morgan Company, Limited, have changed the title of the Company to Wellman, Seaver & Head, Limited.

MESSRS. R. B. FRASER and A. M. BROWN, who traded as A. & R. Brown & Company, engineers, etc., Liverpool notify a dissolution of partnership.

THE ARMORDUCT MANUFACTURING COMPANY, LIMITED, have purchased the patent obtained by Mr. H. C. Pearson, of Manchester, for his grip-conduit fitting.

BEFORE the members of the Sheffield Society of Engineers and Metallurgists recently a short lecture was delivered by Professor Arnold on "Factors of Safety."

THE BRIGHTSIDE FOUNDRY AND ENGINEERING COMPANY, LIMITED, have during the month turned out two of the largest castings ever made in Sheffield, each weighing 95 tons.

J. & R. RITCHIE, LIMITED, of Middlesbrough, are supplying 35 tons of 7-in. diameter cast-iron pipes and other castings to the Blyth Urban District Council at £4 15s. 9d. per ton.

MESSRS. MURRAY, LOTZ & COMPANY, 102, Fenchurch Street, E.C., have been appointed sole English and Continental agents for the Partick Brass and Copper Works (A. Low), Glasgow.

MESSRS. A. H. FLEUSS and J. P. SPARKES, mechanical engineers, Twickenham, Middlesex, trading under the style of the Dignus Engineering Company, have dissolved partnership.

MR. MONTE CALLOW has closed his business at Ipswich, and has joined Messrs. Marples, Leach & Company, engineers, of 6, Victoria Avenue, Bishopsgate Street Without, London, E.C.

AT Sheffield, recently, 25 £5 fully paid Cammell, Laird & Company ordinary shares sold for £5 1s. each, and 30 £1 fully paid Hadfield's Steel Foundry Company ordinary for £3 15s. each.

JOHNSON & PHILLIPS, LIMITED, state that the agreement which they had with Messrs. Welding & Company, to represent them in the counties of Lancashire and Cheshire has been terminated.

MR. W. VON ROMBERG, of Billiter Square Buildings, Billiter Street, London, E.C., has taken over the British agency of the Deutscher Kaiser Company, of Bruckhausen (Rhine), Germany.

MR. H. J. BRACKENBURY, of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, addressed a meeting of the Coventry Engineering Society, recently upon "Modern Machinery and its Future Development."

MR. A. R. HICKLEY, of Chelmsford, has acquired the Engineering Works, Chelmsford, of Coleman & Morton, Limited, and will carry them on in conjunction with Mr. Howell, hitherto foundry manager at the works.

THE LINWOOD MACHINE TOOL COMPANY, LIMITED, is being voluntarily wound up, as also is the Bridgeton Foundry Com-

pany, Limited, the Oakley Steel Foundry Company, Limited, and the Solway Engineering and Ship Repairing Company, Limited.

MESSRS. R. A. KING & COMPANY, 66, Victoria Street, London, S.W., have been appointed London representatives of Messrs. Millen & Sommerville, Tradeston Iron Works, Glasgow; Messrs. Smithson, Sharpe & Company, Hulme, Manchester; and Messrs. Laurie & Company, West End, Falkirk.

MESSRS. H. J. KING & COMPANY, Newmarket Engineering Works, Nailsworth, Gloucestershire, have recently been granted the licence to make and supply the Whitmore patent overwinder and brake engine for existing engines in Great Britain, by Fraser & Chalmers, Limited, of London and Erith.

THE STANTON IRON WORKS COMPANY, LIMITED, near Nottingham, have secured a contract to supply 442½ tons in 600 15 in. by 12 ft. long cast-iron spigot and socket pipes, also one ton in seven 9 in. by 9 ft. long, and about 4½ tons of special pipes, to the Llandudno Urban District Council at a total cost of £2,216 10s. 5d.

THE elaborate new shops and shipbuilding yards at Tranmere Bay of Cammell, Laird & Company, Limited, are now approaching completion. Up-to-date building berths have been constructed capable of taking vessels of the "Dreadnought" and "Mauretania" types. The boiler, engineering, and carpenters' shops which have been erected are on an equally extensive scale, one of the new buildings having a length of 1,100 ft. Electric driving power will be employed throughout the works, with hydraulic power also brought into extensive use.

OWING to the measure of success which has attended the small foundry, recently built by Mr. H. F. Morriss at Rotherhithe, it has become necessary to work on a much larger scale. With this object in view, Mr. Morriss has acquired premises at 13 and 15, Union Road, 6 and 8, Prospect Street, and Paradise Street, Rotherhithe, S.E. These properties adjoin, and have a large area covered with suitable buildings. Here, new furnaces and boilers are in course of construction. The new undertaking has been turned into a small limited company, under the style of the Maravilla Metal Works, Limited, with offices at 25 and 26, Lime Street, London, E.C., and Mr. H. F. Morriss as managing director.

PERSONAL.

MR. C. C. MACRAE has been elected a director of the Blaenavon Company, Limited.

THE late Mr. J. MACKRELL, ironfounder, Elland, Yorkshire, left estate valued at £28,634 gross.

MR. E. W. TAYLOR, managing director of the Tredegar Iron and Coal Company, Limited, has been seriously ill.

SIR WM. H. HOULDSWORTH, BART., has sent in his resignation of the presidency of the Machinery Users' Association (Incorporated).

NEARLY £10,000 has been subscribed by friends of the late Sir David Dale to promote a memorial in recognition of his public work.

THE gross value of the estate of the late Mr. R. V. Sellers, of Darling & Sellers, Limited, machine tool makers, Keighley, is £8,144.

MR. A. L. BOYLE has been appointed on the staff of Messrs. May & Hawes, consulting engineers, Caxton House, Westminster, London, S.W.

MR. J. W. SKENTELBERRY, managing director of the Shields Engineering Company, Limited, has joined Smith's Dock Company as their engineering manager at Middlesbrough.

THE late Sir. Wm. G. Pearce, chairman of the Fairfield Shipbuilding and Engineering Company, Limited, left estate valued at £463,364 gross, including £325,638 net.

MR. W. T. LINTERN, chief assistant to Beardmore & Company, Limited, Parkhead Works, Glasgow, has been appointed chief engineer at the Ebbw Vale Iron and Steel Works.

MR. H. G. YOUNG, engineer and assistant manager to the National Electric Construction Company, Musselburgh, has been appointed manager of the Bo'ness Electricity Works.

MR. C. SIMMONS, for some considerable time with Henry Berry & Company, Limited, of Leeds, has now joined the staff of the Brightside Foundry and Engineering Company, Limited, of Sheffield.

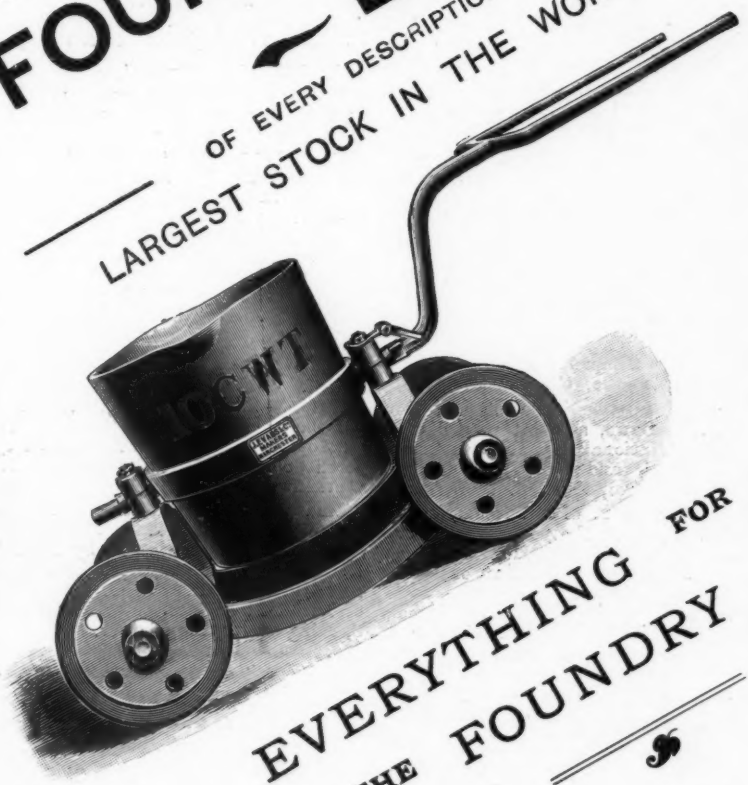
MR. J. A. REAVELL, who, as we announced last month, has resigned his position as general manager to Manlove Alliott & Company, Limited, has joined the board of the Kestner Evaporator and Engineering Company, Limited as managing director.

Contractors to H.M. Government.

FOUNDRY LADLES

OF EVERY DESCRIPTION.

LARGEST STOCK IN THE WORLD.



EVERYTHING FOR THE FOUNDRY

JAMES EVANS & CO.,

Telegrams:
"LADLES, MANCHESTER."
"BLACKINGS, GLASGOW."

BRITANNIA WORKS, MANCHESTER.

DEATHS.

MR. W. WARD, proprietor of the Long Melford Foundry.

MR. H. GUY, hydraulic engineer, etc., Manchester, aged 40 years.

MR. T. SCOTT, of Messrs. Scott, Sons & Watts, engineers, Glasgow.

MR. P. BUCHAN, engineer, of Caledonian Road, Chichester, aged 72 years.

MR. N. B. SMITH, manager of the Stapenbridge Iron Works, in his 59th year.

MR. JOHN HALL, a director of the Yorkshire Engine Company, Limited, in his 84th year.

COLONEL E. SANDERSON TOZER, of the well-known firm of Steel, Peech & Tozer, Limited, Sheffield.

MR. E. FIRTH, a director of Thomas Firth & Sons, Limited, Sheffield, until he retired 10 years ago.

MR. W. J. PRIM, who for many years held the post of resident engineer at the Houses of Parliament.

MR. E. GRIFFITH, a partner in the firm of Messrs. Denny & Company, engineers, Dumbarton, at the age of about 40 years.

MR. T. T. BLACKADDER, analyst to the Shotts Iron Company, Limited, and metallurgist to the Carron Company, Limited.

MR. F. H. ORME, at one time a director of the National Gas-Engine Company, Limited, and latterly managing director of Metres, Limited.

MR. W. HORNSBY, of Grantham, aged 69 years. He was the youngest son of the late Mr. Richard Hornsby, the founder of the well-known firm of agricultural engineers at Grantham, and after completing his education, entered the firm of which he became a director

NEW COMPANIES.

COVENTRY ENGINEERING AND PATTERN COMPANY, LIMITED.—Capital £2,000.

HUMPHRIS ENGINEERING SYNDICATE, LIMITED.—Capital £4,800 in £1 shares.

W. H. A. ROBERTSON & COMPANY, LIMITED.—Capital £6,000, to acquire the Lynton Engineering Works, Bedford.

R. E. MACHINE COMPANY, LIMITED.—Capital £10,000 in £10 shares. Registered office: 4, Bloomsbury Place, W.C.

GRIFFIN FOUNDRY, LIMITED.—Capital £6,000, to take over the business of F. E. Challens. Registered office: Stephenson Street, Birmingham.

BARNARDS, LIMITED.—Capital £45,007, to take over the business carried on by Barnard, Bishop & Barnards, Limited, Norfolk Iron Works, Norwich.

DAVID CAIRD, LIMITED. — Capital £10,000 in £1 shares, to acquire the business carried on at Furness Foundry, Barrow, as executors of the late David Caird.

JOSEPH EVANS & SONS (WOLVERHAMPTON), LIMITED.—Capital £125,000, to acquire the engineering business carried on at Heath Town, Staffordshire, as Joseph Evans & Sons.

G. HOPKINS & SONS (CLERKENWELL), LIMITED.—Capital £10,000, to acquire the engineering business carried on by G. Hopkins as G. Hopkins & Sons. Registered office: 154, St. John Street, Clerkenwell, E.C.

MIRRLEES, BICKERTON & DAY, LIMITED.—Capital £110,000, to acquire the business carried on at Glasgow by the Mirrlees Watson Company, Limited, so far as it relates to the sale or manufacture of Diesel oil engines. Registered office: 8, King Street, Manchester.

Ganister, Cupola Blocks, Fire Bricks,
Fire Clay.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
Steel Moulders' Composition, Silica Cement.

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DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

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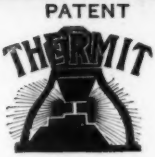
ALUMINO THERMIC 

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As supplied to the British . . Admiralty Dockyards.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

Elders Navigation Collieries, LTD. Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	1907-8.	1906-7.
Iron—Scotch pig warrants ... ton	*57/6	*67/6
—Middlesbro' warrants ... ... ton	48/7	60/7½
—W.C. M/nos Bessemer ... ... ton	67/0	83/0
—Stock, Scotch, Dec. 31 ... ... tons	1,174	9,300
Copper—Chili bars, GMB ... ... ton	£61 17/6	£105 5/0
—Stock, Europe & afloat... ... tons	19,710	16,924
Tin—English ingots ton	£125 10/0	£193 10/0
—Straits ... ton	£121 0 0	£192 5/0
—Stock, Ldn. Hind and afloat ... tons	12,452	13,320
Lead—English pig ton	£15 2/6	£20 5/0
Spelter—Ord. Silesian ... ... ton	£19 5/0	£28 2/6
Quicksilver-(75lb.) bottle	£8 4/6	£7 0/0
Antimony—Regulus ... ... ton	£33-£35	£113-£115

*Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	7 0 0	to	7 5 0
Pipes, 1½ to 2½ in.	5 5 6	to	5 10 0
,, 3 to 4 in.	4 17 6	to	5 0 0
,, 5 to 8 in.	4 15 0	to	4 17 6
,, 10 to 16 in.	4 15 0	to	4 17 6
,, 18 to 24 in....	4 15 0	to	4 17 6
Chairs	3 15 0	to	3 17 6
Floor plates (open sand)	3 0 0	to	3 2 6

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows: — Heavy wrought (mixed), £2 10s. 0d.; light wrought, £1 7s. 6d.; heavy cast, £2 7s. 6d.; all per ton f.o.b., London. Copper (clean), £53 0s. 0d.; brass (clean), £40 10s. 0d.; lead (usual draft), £11 10s. 0d.; tea lead, £9 15s. 0d.; zinc, £15 5s. 0d.; all per ton delivered merchant's yard.

SILICA FIRE BRICK Co.,

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GROUND GANISTER,

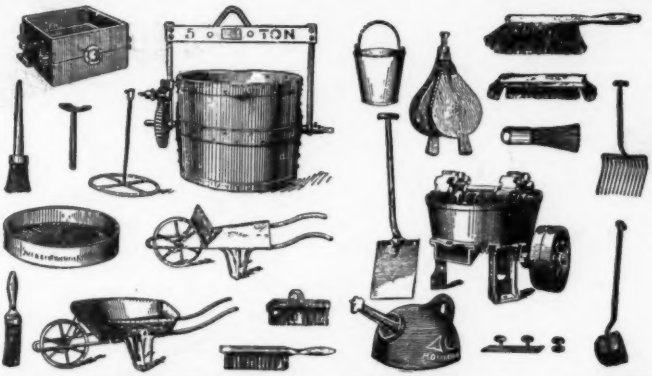
Wet or Dry.

Silco Cupola Bricks, 90 % Silica.

Better than Fire-clay Bricks for Cupolas.

Established 1863.

Jas. Durrans & Sons,



PHŒNIX WORKS, PENISTONE, Near Sheffield.

Manufacturers of all

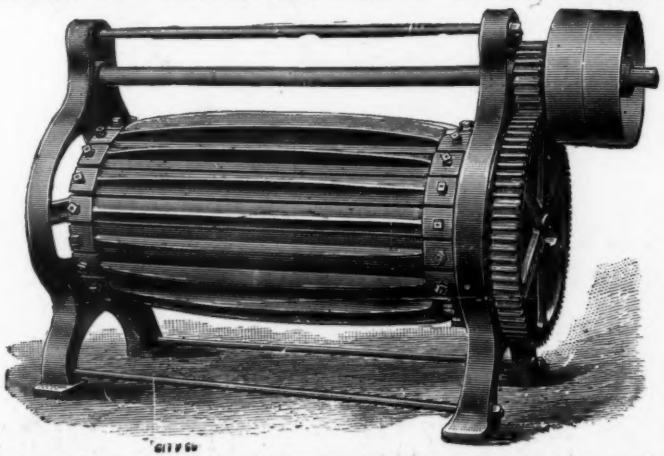
FOUNDRY EQUIPMENTS,

Composition Black Lead,

Plumbago, Core Gum, White Dust, and Coal Dust.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, &c.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



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"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

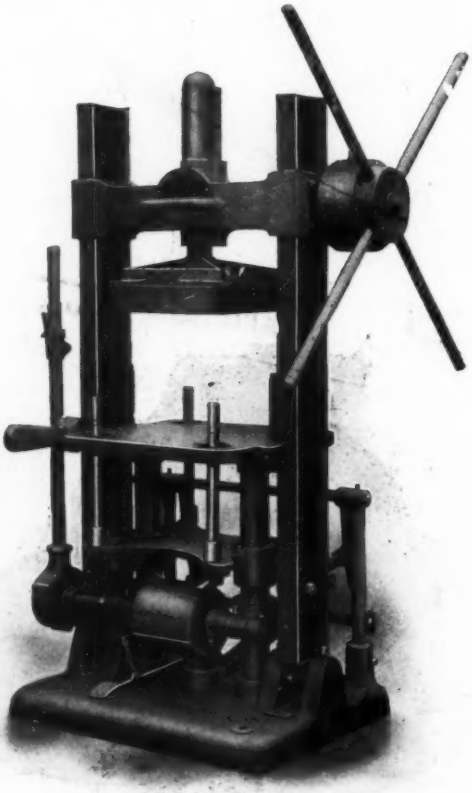
"Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

THE "COVENTRY"

MOULDING MACHINE.

(By Royal Letters Patent.)

A Power Machine



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FOREMAN MOULDER, EXPERIENCED in Hydraulic and Engineers' Castings, also repetition work: non-society; age 39; good references.—Address A. H., 49, Baker Street, Luton, Beds.

PATTERN-MAKER.—Wanted, a thoroughly capable man as manager of pattern room in muslin manufacturer's warehouse; state experience. — Box 607, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

NOTICE.

CARNEGIE RESEARCH SCHOLARSHIPS.

THE Council of the Iron and Steel Institute will shortly proceed to award RESEARCH SCHOLARSHIPS founded by Mr. Andrew Carnegie.

Candidates, who must be under 35 years of age, must apply before February 29th on special Forms to be obtained from BENNETT H. BROUGH, Secretary, Iron and Steel Institute, 28, Victoria Street, London, S.W.

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FOR SALE, FOUNDRY, up to date, with house, plant, shops and tools complete. Owner retiring. — Address BREHAUT, St. Sampsons, Guernsey.

FOR SALE, PATENT ROOTS' BLOWERS:—

No. 1a size	"Allday's"	6 in.	outlet, as new.
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,, 2 ,,	,,	8 in.	,, ,,
,, 4 ,,	"Baker's"	11¼ in.	,, ,,

Three Air Compressors.

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(*Continued.*)

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FOR SALE, 7cwt. Steam Hammer, 10in. cylinder, 24in. stroke, piston 4in. diameter, separate hammer block, first-class condition; total weight 7 tons. — PERCY, High Street, Cullompton, Devon.

IRON FOUNDRY, NEAR BIRMINGHAM. Cast Three Ton Casting; vast stock; general patterns; low rates; magnificent yard; working order; Price £1,200, or nearest offer. — JAMES DAVIES, Engineer, Wednesbury.

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VERTICAL SPINDLE MOULDING MACHINE, by Kirchner, table 39in. by 35in., complete with countershaft, cutter, etc.

FRET SAWING MACHINE, with 30in. square canting table, by Robinson.

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They have solid heads and Shouldered Studs.
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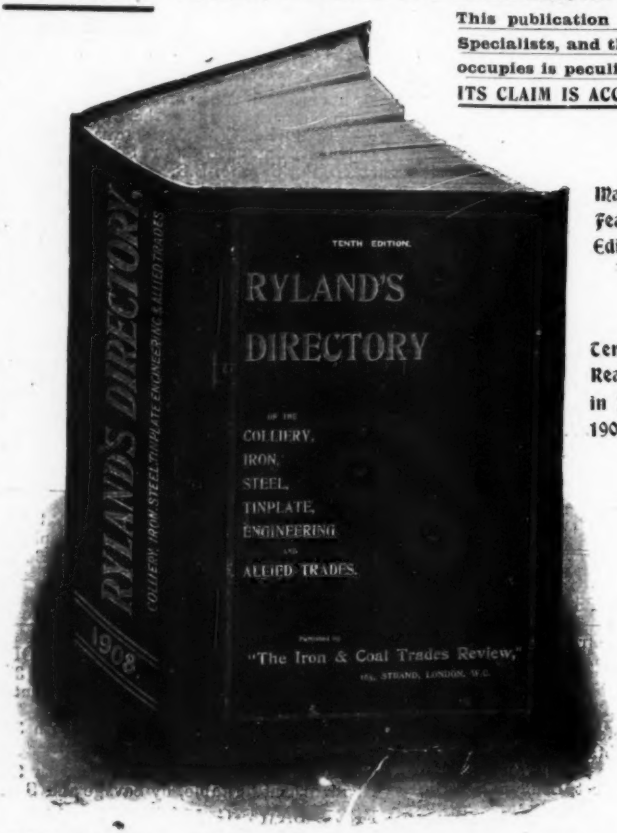

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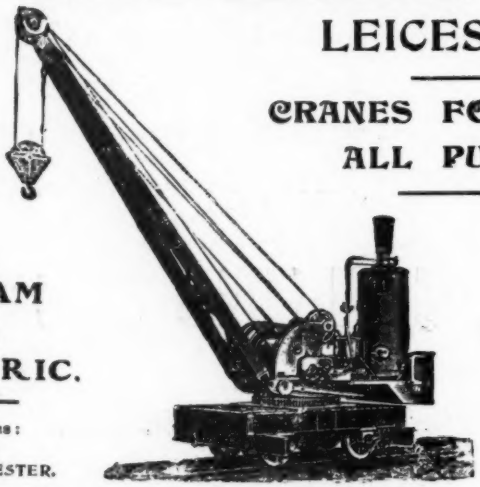

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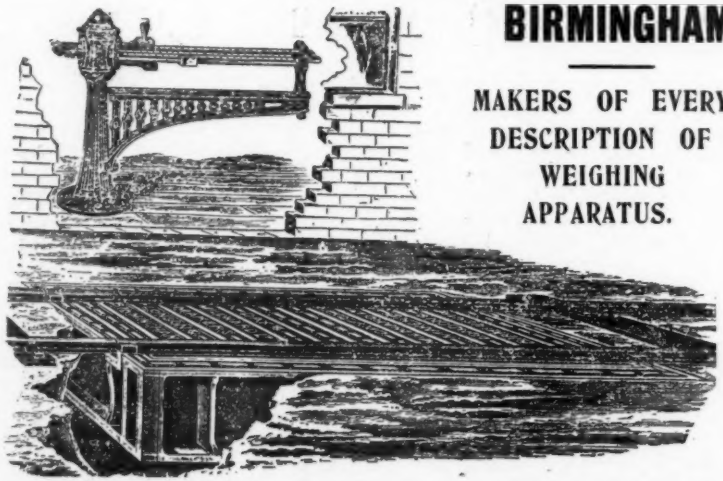

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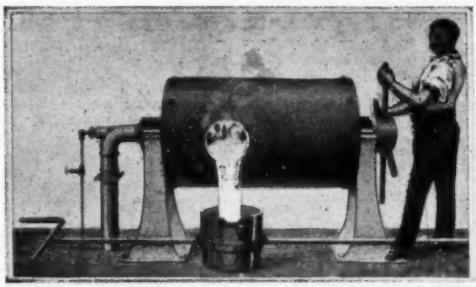

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NOTE! The General Founder who melts a great variety of Metals in the course of a day may think the Charlier Furnace will not accommodate itself to the conditions ruling in his shop. But such is emphatically not the case. The point overlooked is that the Furnace is quite Six times as Rapid as a Coke Fire, therefore from a No. 2 Furnace quite Four Heats of 100 can be run in one hour, say over 30 in a day, allowing ample time to clean out after each charge. Demonstrations by Appointment.

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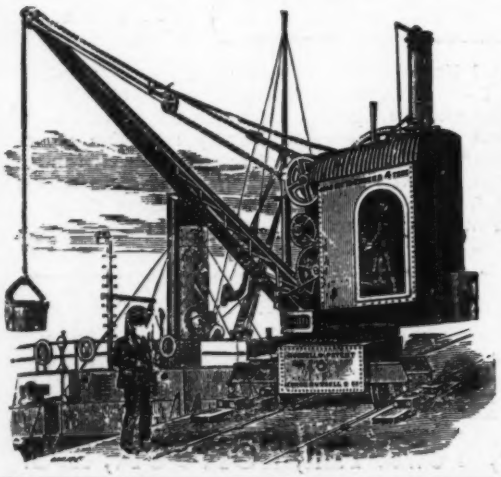

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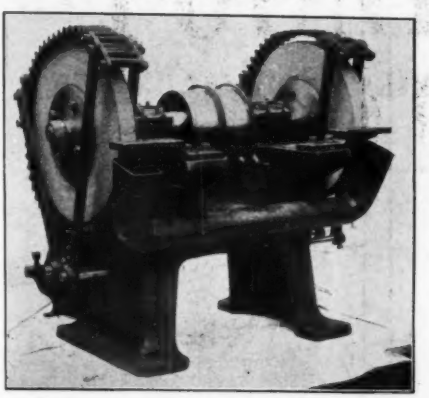

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For
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18 ft. long and
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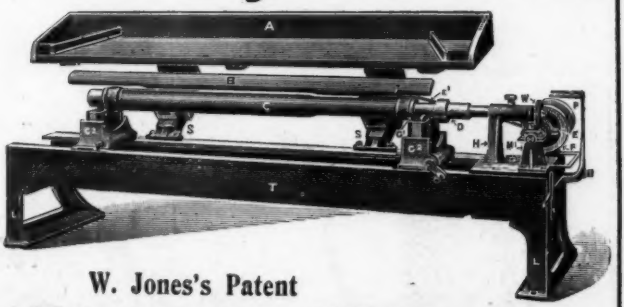

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JONES & ATTWOOD,
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Special . .

Quality . .

FIREBRICKS

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38¼"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS,
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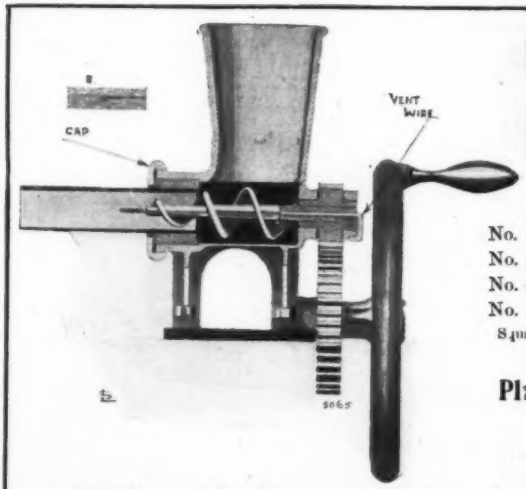
32½"

Can also be made in Aluminium.



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ROTARY TYPE.

No. 1 Capacity, ⅜" to 1½" round.
No. 2 ,, ⅜" to 2¼" ,,
No. 4 ,, ½" to 3" ,,
No. 5 ,, 2½" to 7" ,,

Square, Oval, and Flat Dies to order.

Plunger Type for Brass Foundries,

Capacity, $\frac{3}{16}$" to ¾".

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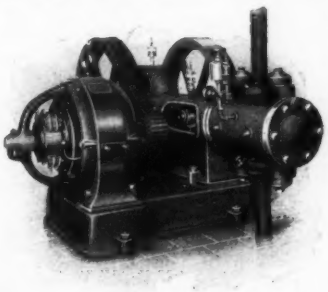

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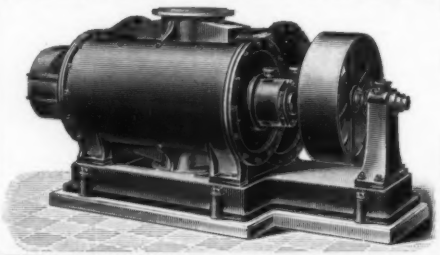

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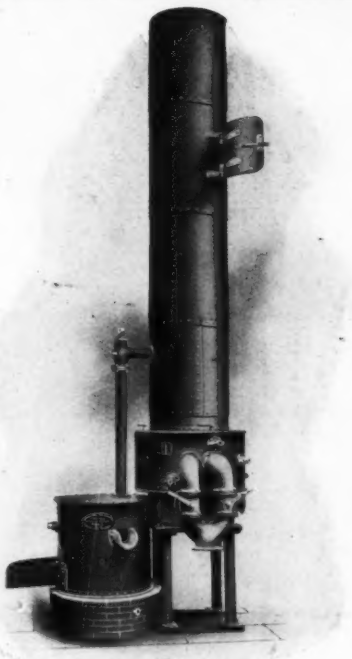

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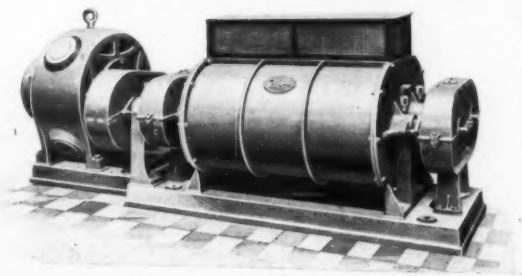

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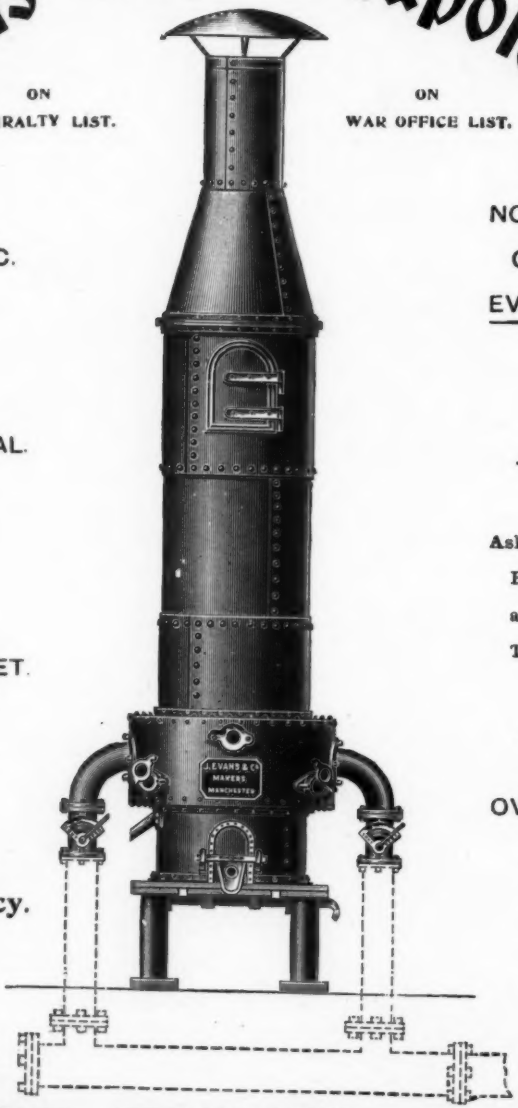

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